TEK PRODUCTS 1984

Computer Graphics Products Softwar
Plug-in & Portable Oscilloscopes OEM
Data Comm Testers Logic Analyzers G
GPIB Programmable Instruments Sign
al Processing Systems Semiconducto
Test Systems Curve Tracers Cable Tes
ers Microcomputer Development Proc
TV Demodulators Vectorscopes Gene
rators Waveform & Picture Monitors A
Automatic Measurement Set Spectrur
Analyzers & Swept Frequency System
Digitizers TDR Photometer/Radiomet
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1

IMPORTANT INFORMATION

43

DESIGN AUTOMATION DIVISION

95

INFORMATION DISPLAY DIVISION

147

COMMUNICATIONS DIVISION

226

INSTRUMENTS GROUP

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Indexes 2
Functional and alphanumeric indexes for quick, easy access.

Color Products Reference 9
An overview of Tek's expanded spectrum of color products featuring applications, an explanation of how color displays are formed, and how color is specified and perceived.

GPIB Products Reference 25
An overview of some of the important factors in selecting products to meet your needs. Tektronix GPIB product systems are described, as well as individual waveform measurement instruments, graphic controllers, and peripherals.

Customer Services & Information 36
Details about ordering, training, calibration maintenance, repairs, parts, service, terms of sale and warranty.

Power Source Considerations 42
Information on power sources and power cord-/plug options.

Sales and Service Offices 462-465
A complete listing of Tektronix worldwide sales and service offices. Consult the listing for the one nearest you.

IMPORTANT INFORMATION

Microcomputer Development Products 45
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INFORMATION DISPLAY

Fiber Optic TDR Cable Tester 148
The OF150 is capable of making quantitative, calibrated loss and distance measurements on multimode fiber optic cable and installations.

Metallic TDR Cable Testers 150
These TDR cable testers provide installation and maintenance people with fast, accurate, portable tools for checking the internal condition of fiber optic and metallic cables and locating faults.

Communication Network Analyzers 152
The 830 Series family of Data Communications Testers are designed to identify faulty elements in a data communications network. The 834 offers a high degree of programmability which allows easy go/no-go testing.
The 851 Digital Tester is a first-line, multifunctional service instrument developed to meet the needs of the digital service industry.

Television Products 159
Tektronix Television Products time, test, measure, correct and display the television signal worldwide.

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COMMUNICATIONS

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GPIB programmable measurement instruments supported by a selection of instrument controllers, peripherals, and software.

Digitizers 336
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Signal Processing Systems 353
Waveform Digitizing Instruments & Systems with specifically designed digitizers, systems and software.

TM 5000 GPIB Programmable Instruments 358
Modular, integrated, compact line of fully programmable GPIB instruments including signal sources, measurement devices, and a family of interface devices.

TM 500 General Purpose Instruments 373
Approximately 40 manual, general purpose instruments—counters, DMMs, function, pulse, and signal generators, power supplies, signal conditioners, plus others—which are also compatible with TM 5000.

Curve Tracers 407
Deliver comprehensive information about a multitude of semiconductor devices and integrated circuits.

Photometer/Radiometer 417
Measures luminance, illuminance, irradiance, light-emitting diode output, & relative intensity.

Cameras, Isolators, Probes Carts and Accessories 421
Extend your measurement capabilities. Contains selection guides, charts, descriptions, and specifications.

INSTRUMENT SYSTEMS

A

A to D Converter 276,370
AC RMS Digital Voltmeters 308,363,383
Accessories
Cables 458
Probes 456
Sampling 279,281-282,387
Spectrum Analyzer 225
TM 5000/TM 500 404-406
Viewing 461
Accessory Power Supply 443
Adaptors
BNC 458
BSM 458
Cable Input 458
Camera Mounting 425
Curve Tracer 416
F 459
GR 458
N 458
Personality Module 81
Probe 458
Probe Grounding 458
Rack 460
Socket 416
SMA (3 mm) 459
Aids, Digital Servicing 63,75,158,387,389
Air Line, GR 458
Alphanumeric Terminals 95-99
Amplifiers
CATV Preamp 224
Current Probe 392,437,447,448
Differential 266,295,393
Differential Comparator 266,295
Dual Trace 264,281,289,294,297
Dual Trace Differential 296
Four Trace 294
Logic Triggered Vertical 268
Operational 393
Programmable 345,347
Single Trace 263-267,279-280,294-296
Waveform Digitizer 293
Amplitude Generator, Constant 400
Analyzers
Audio 367,391
Data 63,75
Data Communications 152
Distortion 367,391
Logic 60
Spectrum 209
Television Sideband 219,224
APL Terminals 123
Application Notes
Portable 300
7000 Series 242
5000 Series 286
ATB, Spectrum Analysis 211
Attenuators
BNC 458
GR 458
N 458
SMA (3 mm) 459
Audio Analyzers 367,391
Audio Sweep Generator 390
Audio Test System, Programmable 367
Automated Test Equipment 88,327-357
Automatic Video Corrector 202
Automatic Video Measurement Set 168

B

Battery Operated Oscilloscopes 298
Battery Pack 161
Battery Power Supply 313,405
Bistable Storage Monitors 144
Bistable Storage Oscilloscopes 256-260, 290-292,314-326,396
Blank Panel Plug-in Chassis 406
BNC, Accessories 458
BSM, Accessories 458

C

Cabinets, Plug-in Storage 460
Cable Input Adaptors 458
Cable Testing
Fault Locating 148
Fiber Optic 148
Metallic 150
Time Domain Reflectometer (TDR) 148,150
Cables
BNC 458
BSM 458
GR 458
N 458
SMA (3 mm) 458
Calibration Fixtures 206
Calibration Generators 398-400
Calibration, Oscilloscope 398-401
Calibration and Other Services 38
Camera Adaptors 425
Camera Carrying Cases 429
Camera Mounting Adaptors 425
Camera Writing Speed Enhancer 423
Cameras, Scope/CRT Display 425-429
Capacitors, Coupling 459
Cards
Programmable A/D Converter 370
Programmable D/A Converter 370
Programmable Development 371
Programmable Digital Input/Output 371
Programmable Memory 370
Programmable Relay Scanner 369,371
Carrying Cases, Camera 429
Carrying Cases, Plug-in 225,461
Carts, Lab/Portable Instruments 431
Carts, SCOPE-MOBILE® 431-432
CATV Preamp 224
Chassis, Blank Panel Plug-in 406
Color Digital Analysis Mainframe 64-69
Color Graphics Copiers 102,103
Color Graphics Terminals 96-100,104,107,125
Color Storage Oscilloscope 292
Color Television Picture Monitors 182-187
Communications Test Equipment
Analyzers
Data 63,75
Sideband 219,224
Spectrum 209-225
Automatic Video Measurement Set 168
Cable Fault-Locaters 148-151
Demodulators 203
Frequency Counters 275,360,374
Generators
Audio Sweep 367,390
Noise Measurement Set 201
Synchronizer 162
TV Oscilloscopes 273,321,326,350
Vectorscopes 159,175,179,180
VITS Inserters 164,198,200
Waveform Monitors 159,177
Comparison Charts
Camera and Mounting Adaptors 424
CRT Phosphor Data 230
CRT Storage Oscilloscopes 233
Digital Storage Oscilloscopes and Waveform Digitizers 233
Digital Counters 374
Digital Multimeters 382
Digital Photometer/Radiometer 419
Digitizers 336
Function Generators 378
Logic Analyzers 63
Modular Nonstorage Oscilloscopes 231
NTSC Signal Generators 188
Oscilloscope Calibration Product Guide 398
Oscilloscope Cameras 425
Portable Nonstorage Oscilloscopes 231
Portable Oscilloscopes 299-300
Power Supplies 388
Probes 438-441
Pulse Generators 385
TM 500 Oscilloscopes 394-397
7000 Series Oscilloscopes 240-242
5000 Series Oscilloscopes 284-286
Computer-Based Systems, Desktop 128-130
Computer Controlled Oscilloscopes 353-357
Computer Graphics Products
Color Graphics Copier 102
Computer Display 98-100,104-109, 122-125,144-145
Display Terminals 98-100,104-109, 122-125,144-145
Dual Flexible Disk 110
Graphic Systems 112-121,128-130
Graphic Tablets/Joystick 138
Hard Copy Units 133
Hard Disk, 10 Megabyte 110
Imaging Recorder 139
Interactive Digital Plotter 136
Interactive Graphic Units 96-125
Local Graphics Processing Unit 101
Storage Display Monitors 126,140
Connector Accessories 458
Controller, Cluster 111
Controller, Programmable Switch 372
Controllers, System 28,128,130,331
Constant Amplitude Generator 400
Converters
A to D 276,370
D to A 370
Copier, Color Graphics 102,103
Copy Units, Hard 133
Cords, Patch 458
Corrector, Automatic Video 202
Counters, Digital
Frequency 275,360,374
Time Interval 275,360,374
Universal 275,360,361,374,375
Counter/Timer 377
Counter/Timer/DMM Oscilloscope 308
Coupling Capacitors 459
Covers, Protective 461
Cradle Mount 460
CRT
Light Filters 461
Mesh Filters 461
Readout Oscilloscopes 236-261,287-288, 291-293,340
Readout Plug-in 267
CRT Displays (see Displays)
Current Measuring Equipment 276,295, 382,392,437,447
Current Probe Amplifier 392,447
Current Probes 392,437,447-449
Curve Tracer Adaptors 416
Curve Tracer, Integrated Circuit 414
Curve Tracers, Semiconductor 407

D

D to A Converter 370
Data Acquisition Modules 66
Data Acquisition Probes 84
Data Acquisition Systems 353-357
Data Analyzers 63,75
Data Comm Analyzers, Testers 152
Decoders, NTSC/PAL Comb 185
Delayed Sweep Oscilloscopes 243-261, 270,272,281-286,297,301,314,321,340,350
Delayed Sweep Sampling Plug-in 281
Delaying Time Bases 270,272,281,289,297
Demodulators, Television 203
Desktop Computer Based Signal Process Systems 357
Desktop Computer ROM Packs 116
Development Instruments, Digital 60
Development Products, Microcomputer ... 45

Development Unit, Multiuser Software 48
Differential Amplifiers 266,295,393
Differential Comparator Amplifier 266,295
Differential Input Oscilloscope 243-261, 266,287,340,348
Differential Amplifier, Dual Trace 296
Differential Probes 437,444,455
Digital Analysis Mainframes 64-69
Digital Cartridge Tape Recorder 131
Digital Counters 275,360,374
Digital Delay 274,387
Digital Delay Oscilloscope 243-261,274, 340,387
Digital Development Instruments 60
Digital Generator/Inserter 164
Digital Input/Output Card 371
Digital Latches 60,387,389
Digital Multimeters
Oscilloscope Coupled w/Temperature 276,322
DMM Oscilloscope 276,306,309,315,317, 321,363,382-384
Digital Photometer/Radiometer 417
Digital Plotter, Interactive 136
Digital Prescaler 363,376
Digital Readout Oscilloscope 236-261, 287,293,303-309,315,321,340,350-352
Digital Servicing Aids 75,158,387,389
Digital Service Instrument 75,80,158
Digital Storage Oscilloscopes 299,340, 348,350,352
Digital Storage Spectrum Analyzers 218
Digital Sweep Generators 207
Digital Tester 152
Digital Voltmeters 363,383-384
Digitizer Amplifier, Waveform 293
Digitizers 336-352
Digitizer Time Bases 347,349
Digitizing Oscilloscopes 336-352
Disc Storage Memory 132
Disk, 10 Megabyte Hard 110
Disk, Dual Flexible 110
Display Formatter 63
Display Terminals 104
Displays (CRT)
Bistable Storage 144
Color Television Picture 182,184
Color Display 185
Computer 97-100,104-109,122-125,144-145
High Brightness 140,185
High Resolution 141,185
Large Screen 145,182
Nonstorage 141
OEM 140-145
Portable Video Test 175
Raster Scan, Video 141,185
RGB Color 185
Storage Display 126,144-145
Television Waveform 177-181
Vector Display 179
X-Y 140-143,179
Distortion Analyzers 367,391
DMM Oscilloscopes .. 276,306,308,315,317,321
Dual Beam Oscilloscopes 254,290
Dual Beam Storage Oscilloscopes 290
Dual Time Base (Mixed Sweep) . 271,273,297
Dual Trace Amplifiers 264,281,289,294,297
Dual Trace Differential Amplifiers 296
Dual Trace Digital Storage Oscilloscope 350,352
Dual Trace Oscilloscopes 243-261, 284-295,298-315,318-326,340,350,394-397

E

Events Delay 274
Extender, Multifunction Interface 369

F

F Adaptors 459
Fast Rise Pulse Generator 282-283,385-387
Fast Transfer Storage Oscilloscopes 321
Fault Locating Cable Testing 148-150
FET Probes 437,443
Fiber Optic Cable Testers 148
File Manager 131
File System, Multiuser 132
Filters
Bandpass/Amplifier 393
CRT Light 461
CRT Mesh 461
Flexible Disk, Dual 110
Floating Measurements (Isolated) 433-436
Formatters, Display 63
Four Trace Amplifiers 294
Four Trace Oscilloscopes 303
Frequency Counters 275,360,374
Function Cards 369
Function Generators 365,378-381

G

Gate Array Layout System 114
Generators, Signal
Audio Sweep 367,390
Calibration 398-400
Constant Amplitude 400
Digital Sweep 207
Fast Rise Pulse 282-283,385-387
Function 365,378-381
High Frequency 386
NTSC 189-195,200
PAL and PAL-M 189-199
Pulse 282-283,386,387
Ramp 378-381
Rate/Ramp 381
RC Oscillator 401
SECAM 197
Sinewave 378-381,401
Squarewave 380
Television Sync 189
Television Test 190-198
Time-Mark 400
Tracking 223
Triangle 380-381
GPIB Products
A to D Converter 370
Audio Test System 32,367
Cables 35
Calibration Generator 33,398-399
Controllers 28,128,130,331
Counter/Timers 33,360,361,375
D to A Converter 33,370
Desktop Computers 34,122
Digital Multimeter 33,382
Digital Plotter, Interactive X-Y 35,136
Digital Storage Oscilloscope 31,299,340, 348,350,352
Digitizers 31,336-352
Digitizer Systems 32,353-357
Digitizing Oscilloscope 31,348
Distortion Analyzer 32,367
Extender 35,132
File Management System 35,132
Interface 35,369
Logic Analyzer 34,58
Multiplexer 35,354
Power Supplies 33,366,388
RF Scanner 33,372
Spectrum Analyzers 35,211-216
Waveform Processing Oscilloscopes 31,340
Waveform Processing Systems 32,353-357
GPIB Reference 25-35
GR Accessories 458
Graphic Computer Terminals 96-100, 104-109,122-125
Graphic Units, Interactive 96-125
Graphics Processing Unit, Local 101
Graphics Products, Computer
(see Computer Graphics Products)
Graphics Software Library 114-121
Ground Adaptors, Probe 461
Ground Isolation Monitor 433-436
Ground Leads, Probe 456

H

Hard Copy Units 133
Hard Copy Video Units 134
Hard Disk, 10 Megabyte 110
High Brightness Monitor 184
High Current Transformer 392,447,449
High Frequency Oscilloscopes 242-261, 301-309,340,350
High Frequency Signal Generators 386
High Gain Oscilloscopes 236-261,284-292
High Resolution Monitor 141,182,185
High Resolution Color Storage Scope 292
High Voltage Probe 384,433,435,437,454
Hoods, Viewing 461
Housing Accessory, BNC 458

I

Image Forming Module 135
Imaging Recorder 139
Input Adaptors, Cable 458
Input/Output Card, Digital 371
Inserters, VITS 164,198,200
Instrument Carts, Mobile 431,432
Instrumentation, Programmable 25-35, 211-215,337,342-346,353,356-372
Instrumentation Systems 353-357
Instruments, Digital Service 75,80,158
Instruments, Digital Development 60-87
Integrated Circuit Curve Tracer 414
Integrated Circuit Test Equipment 91-92
Integrated Counter/Timer/DMM Oscilloscope 308
Interactive Digital Plotter 136
Interactive Graphic Units 96-125
Interface Extender, Multifunction 369
Interface, Programmable Multifunction .. 369
Isolated (Floating) Measurements 433-436

L

Lab/Portable Instrument Carts 431,432
Latches, Digital 60,387
Leads, Patch Cord 458
Leads, Probe Ground 456
Library, Graphics Software 114-121
Light Filters, CRT 461
Light Measurement 417-420
Local Graphics Processing Unit 101
Locator, Cable Fault 148-151
Logic Analyzers 60
Logic Probe 84,445
Logic Triggered Vertical Amplifier 268
Low Frequency Oscilloscopes 284-297, 310-319,323-326,395-397

M

Mainframes
Color Digital Analysis 64-69
General Purpose Instruments 402-403
Logic Analyzer 70
Matrix, Switch 372
Measurements
Automatic Video 168
Current 276,295,382,392,437,447

Isolated (Floating) 433-436
Light 417-420
Mechanical Transducers 286
Temperature 384,444
Memory Card, Programmable 370
Memory, Disc Storage 132
Mesh Filters, CRT 461
Metallic Cable Tester 150
Microcomputer Development Products 45-59
Microprocessor Support
Logic Analyzers 82
Microprocessor Development Products 45
Personality Modules 81
Microwave, Spectrum Analyzers 209-218
Military Designator Oscilloscopes 252,312
Minicomputer Based Signal Processing Systems 356
Mixed Sweep (Dual Time Base) Oscilloscopes 271,273,297
Mixers, Waveguide 214
Modular Probes 450-453
Modules, Data Acquisition 66
Module, Image Forming 135
Module, Output 149
Monitors
Bistable Storage 144
Color Television Picture 182,184
Color Display 185
Computer 97-100,104-109,122-125,144-145
High Brightness 140,182,185
High Resolution 141,185
Large Screen 145,182
Nonstorage 141
OEM 140-145
Portable Video Test 175
Raster Scan, Video 141,185
RGB Color 185
Storage Display 126,144-145
Television Waveform 177
Vector Display 179
Waveform/Vector 159
X-Y 140-143,179
Mounting Adaptors, Camera 425
Mounting Dimensions and Adaptors 460
Multimeters, Digital (see Digital Multimeters)
Multimode Storage Oscilloscope 232,251, 256-259,321
Multiplexer 354

N

N Connector Cables and Adaptors 458
Network Analyzers, ROM Packs 154-157
Noise Measurement Set, Television 201
NTSC Generators 189-195,200

O

OEM Products 140-145,430
Operational Amplifier 393
Oscillators 367,390,401
Oscilloscope Amplifiers (also see Plug-in Units)
Oscilloscope Calibration Equipment 398-401
Oscilloscope Cameras 425-430
Oscilloscope Carts 431-432
Oscilloscopes
Battery Operated 298
Calibrated (Mixed Sweep) 273,321
Color Storage 292
Computer Controlled 353
Counter/Timer/DMM 308
Coupled with Temperature 276,322
CRT Readout 236-261,287-288,291-293, 303,340,352
Curve Tracers 407-416
Data Analyzer 60-87
Delayed Sweep 243-261,270,272,281, 287,297,301,303,306,308,314,321,340,350
Differential Input 243-261,266,287,340,348,
Digital Delay 243-261,274,340,387
Digital Readout 236-261,287,292,293,303-309, 315,321,340,350-352
Digital Storage 336-352
Digitizing 336-352
DMM 276,306,308,315,317,321
Dual Beam 254,290
Dual Trace 243-261,284-295,298-315, 318-326,340,350,394-397
Dual Trace Digital 352
Four Trace 303
High Frequency 242-261,301-309,321,340,350
High Gain 236-261,284-292
High Resolution Color Storage 292
Low Frequency 284-297,310-319, 323-326,395-397
Military Designator AN/USM 281C 252
Military Designator AN/USM 425 312
Mixed Sweep (Calibrated) 273,321
Nonplug-in 298-326
Plug-in 236-261,284-293,390,395-397
Portable 298-326
Programmable 25-32,337,340
Rackmount 246-251,254,286-288,290-291, 301,308,319,350,394-397,402-403
Ruggedized 252,312
Sampling Plug-in 277-283
Storage
Bistable 256-260,290-292,314-326,396
Digital 299,340,348,350-352
Dual Beam 290
Fast Transfer 321
Multimode 232,256-259,321
Reference Information 243
Variable Persistence . 256-257,259-261,288,321
Television 273,321,326,350
TM 500 394-397
Waveform Processing 353-357,340-341
X-Y Plotting 243-254,284-292,301,315, 321,350,390,397
Output Module 149

P

Pack, Battery 161,313
PAL and PAL-M Generators 189-199
Panel Plug-in Chassis, Blank 406
Patch Cords, Leads 458
Pattern Generator Probes/Modules 60
Performance Analysis (Software and Hardware) 72
Photometer/Radiometer, Digital 417
Plug-ins
General Purpose Instruments 358-402
Oscilloscope 262-283,289,294-297
Plotters, Interactive Digital X-Y 136
Plug-in Carrying Cases 225,461
Plug-in Chassis, Blank Panel 406
Plug-in Storage Cabinets 460
Plug-in Units
Ac RMS Digital Voltmeter 363,383-384
Calibration Generators 398-400
CATV Preamp 224
CRT Readout 267
Current Probe Amplifier 392
Curve Tracers 415
Delayed Sweep Sampler 281
Delaying Time Bases 270,272,281,289,297
Differential Amplifiers 266,295,393
Differential Comparator Amplifier 266,295
Digital Counters 275,360,374
Digital Delay 274,387
Digital Multimeters 276,363,382-384
Digital Prescaler 376
Digitizer Time Bases 347,349
Dual Differential Amplifier 296
Dual Time Base (Mixed Sweep) 271,273,297
Dual Trace Amplifiers 264,281,289,294,297
Dual Trace Differential 296
FET Probe Amp 265
Four Trace Amplifier 294
Logic Triggered Vertical Amplifier 268
Operational Amplifier 393
Oscillators 367,390,397,401
Oscilloscopes 236-261,284-293,390,395-397
Power Supplies
0 to 20 V Variable 366,389
for Plug-in Units 402-406
Programmable 366
Programmable 25-32,337,345,347,358-372
Programmable Distortion Analyzer 367
Ramp Generator 378-381
Rate/Ramp Generator 378-381
RF Sweep Generator 401
Sample/Hold Digital Voltmeter 276
Sampling 277-283
Sampling Heads 282-283
Single Time Bases 270-273,280,289,297,349
Single Trace Amplifier .. 263-267,279-280,294-296
Spectrum Analyzers 217-222
TDR 279
Tracking Generators 223
Universal Counter/Timers 275
Polarized Viewers 461
Portable Instrument Carts, Lab 431
Portable Oscilloscopes 298-326
Ptbl Oscilloscope w/DMM Temp 321
Portable Oscilloscope Power Supply 313
Portable Spectrum Analyzer 210-216
Power Divider, GR 458
Power Divider, SMA (3 mm) 458
Power Supplies
0 to 20 V Variable 366,389
Accessory 443
Battery 405
for Plug-in Units 402-406
Portable Oscilloscope 313
Programmable 366
Preamp Amplifier, CATV 224
Preamp, Spectrum Analyzer 224
Prescaler, Digital 363,376
Printers, Matrix 135
Probe Adaptors 458
Probe Amplifiers, Current 392,447
Probe Chart, Recommended 439-441
Probe Ground Leads 458
Probe Grounding Adaptors 458
Probe Tips 456
Probes
Accessories 456
Active 437,442
Counter 377
Current 392,437,447-449
Data Acquisition 84
Differential 437,444,455
Digital Photometer/Radiometer 418-419
Environmental 445,446
FET and 50 Ohm 437,443
High Current 392,447
High Voltage 384,433,435,437,454
Logic 84,445
Modular 450-453
Pattern Generator 84
Recommendations 437-441
RF 384,446
Temperature 384,444,445
Sampling 440
Voltage 437,444-446,450-455
Word Recognizer 84,439
Programmable Instrumentation (see GPIB Products)

Protective Covers 461
Pulse Generators 282-283,386,387

R

Rack Adaptors 460
Rackmount Model Instrument Carts . 431-432
Rackmount Oscilloscopes 246-251, 254,258-259,286-288,290-291,301-305,319
Ramp Generators 378-381
Raster Scan Display Units 141,185
Raster Scan/Video Hard Copy Units 134
Rate/Ramp Generators 378-381
RC Oscillator 401
Readout Oscilloscopes, CRT 236-261, 287-288,291-293,340
Readout Oscilloscopes, Digital 236-261, 287,293,306,315,321,340,350
Readout Plug-ins, CRT 267
Recorder, Digital Cartridge Tape 131
Recorder, Imaging 139
Reference Information
(see Comparison Charts)
Camera Recommendations 422-425
CRT Phosphors 230
Digitizers 336-352
General Purpose Interface Bus 25-35
Modular and Integrated Oscilloscopes 227
Oscilloscope Specifications 227
Probe Recommendations 437-441
Sales, Ordering, Customer Support 36-42
Sampling Applications 235,278
Signal Processing 353
Storage Displays 231
Waveform Digitizers 234
Reflectometer Cable Testing, Time Domain 148-150
Refreshed Alphanumeric Terminals ... 95-130
RF Probe 384,446
RGB Color Monitors 141,185
ROM Packs
Desktop Computers 116
Network Analyzers 154-157
Ruggedized Oscilloscopes 252,312

S

Safety (Isolators) 433-436
Sample/Hold Digital Voltmeter 276
Sampler, Delayed Sweep 281
Sampling Accessories 279-282,387
Sampling Decision Tree 278
Sampling Heads Plug-in Units 282-283
Sampling Plug-in, Delayed Sweep 281
Sampling Plug-in Units 277-283
Sampling Probes 440
Scanner, Programmable 372
Scanner, Programmable Low Level 369
SCOPE-MOBILE Carts ® 431
Semiconductor
Automatic Test Equipment 88,327,353
Curve Tracers 407
Servicing Aids, Digital 75,158,387,389
Single Time Bases 270-273,280,289, 297,349
Sideband Analyzers, Television 219,224
Signal Generators
Audio Sweep 390
Calibration 398
Constant Amplitude 400
Digital Sweep 207
Fast Rise Pulse 282-283,385-387
Function 365,378-381
High Frequency 386
NTSC 189-195,200
PAL and PAL-M 189-199
Pulse 282-283,386-387
Ramp 378-381
Rate/Ramp 381
RC Oscillator 401
SECAM 197
Sinewave 378-381,401
Squarewave 380
Television Sync 189
Television Test Signal 190-198
Time-Mark 400
Tracking 223
Triangle 380-381
Signal Pickoff 449
Signal Processing Systems
Minicomputer Based 356
Desktop Computer Based 353-357
Signal, TV Correctors 202
Single Trace Amplifiers 263,265,280,294
SMA (3mm) Accessories 458
Socket Adaptors 416
Software Development Unit, Multiuser 57
Software Products 48,114-121,170-174,353-357
Spectrum Analyzers
Accessories 225
Digital Storage 217-218,221-222
Plug-in 217-222
Portable 210-216
Preamp 224
Programmable 211-215
Storage
Cabinets, Plug-in 460
Display Monitors 126,140
Memory, Disc 132
Oscilloscopes, Color 292
Oscilloscopes, Digital 299,340,348,350
Oscilloscopes, Digitizing 336-352
Spectrum Analyzers, Digital 218
Sweep Generator, Audio 390
Swept Frequency Systems 223
Switch Controller, Programmable 372
Switch, Matrix 372
Sync Generator, Television 189
Synchronizer 162
Systems
Automatic Test 88,353
Data Acquisition 353
Desktop Computer Based 357
Graphic 112-121,128-130
Programmable Audio Test 367
Swept Frequency 223
Test and Measurement 327-406

T

Television Products
Automatic Video Correctors 202
Automatic Video Measurement Set 168
Calibration Fixtures 206
Color Picture Monitor 182,184
Comb Decoders, NTSC/PAL 185
Demodulators 203
Digital Sweep Generators 207
Noise Measurement Set 201
Oscilloscopes 273,321,326,350
Sideband Analyzers 219,224
Signal Correctors 202
Sync Generators 189
Synchronizer 162
Test Monitor 175
Test Signal Generators 190-198
Vectorscopes 159,175,179,180
VITS Inserters 164,198,200
Waveform Monitors 177
Waveform/Vector Monitors 159,175
X-Y Monitor 141-143,179
Temperature Measurements 384,444
Temperature Probe 384,444,445
Terminals, Alphanumeric 95,97-109
Terminals, APL 123
Terminals, Color Graphics 96-100, 104,107,125
Terminals, Display 97-100,104-109, 122-125,144-145
Terminals, Graphic Computer 97-100, 104-109,122-125,144-145
Terminals, Refreshed Alphanumeric 95
Terminations
BNC 458
GR 458
SMA (3 mm) 458
Test and Measurement Systems 327-406
Test Equipment, Communications
(see Communications Test Equipment)
Test Equipment, IC 91-92
Test Monitor, Portable Video 159,175
Test Signal Generators 190-198
Test System, Automatic 88-94
Test System, Programmable Audio 367
Testers, Digital 152
Testers, Fiber Optic Cable 148
Testers, Metallic Cable 150
Testing, Cable (see Cable Testing)
Thermal Readout 276,322,382-384
Time Bases, Delaying 270,272,281,289,297
Time Bases, Digitizer 347,349
Time Bases, Dual (Mixed Sweep) 271, 273,297
Time Bases, Single ... 270,273,280,289,297,349
Time Domain Reflectometer, Cable Testing 148,150
Time Interval Counters 275,360,374
Time Mark Generator 400
Tips, Probe 456,457
Trace Recording Cameras 422-430
Tracking Generators 223
Transducers 286
Transformers, High Current 392,447,449
Transistor Curve Tracers 407-416
Transient Digitizer 342-347
Triangle Generators 380

U

Universal Counter/Timers 275,360, 361,374,375

V

Variable Persistence Storage Oscilloscopes 256-257,259-261,288,321
Vectorscopes 159,175,179,180
Video Corrector, Automatic 202
Video Hard Copy Units 134
Video Monitor, Raster Scan 141,185
Video Test Monitor, Portable 175
Viewing Hoods and Accessories 461
VITS Inserters 164,198,200
Voltage Probes 437,444-446,450-455
Voltmeter, Ac RMS Digital 308,363,383-384
Voltmeter, Sample/Hold Digital 276

W

Waveform Digitizer Amplifier 293
Waveform Digitizer, Programmable . 342-347
Waveform Digitizing Instruments 336-357
Waveform Monitors 177
Waveform Processing Oscilloscopes 353-357,340-341
Waveform/Vector Monitors 159,175
Waveguide Mixers 214
Word Recognizer Probe 84,439
Writing Speed Enhancers, Camera 423

X

X-Y Monitor 141-143,179
X-Y Plotting 136

Type	Instrument Description	Page
AA 501	Distortion Analyzer	391
AA 5001	Prgmbl Distortion Analyzer	367
AM 501	Operational Amplifier	393
AM 502	Differential Amplifier	393
AM 503	Current-Probe Amplifier	392,447
AM-6565/U	Amplifier Plug-In	252
AN/USM-281C	Ruggedized Oscilloscope	252
AN/USM-425(V)1	Portable Oscilloscope	312
A6302	Current Probe	392,447
A6303	Current Probe	392,447
A6901	Ground Isolation Monitor	434
A6902A	Isolator	435
BP1	Battery Pack	161
CG 5001	Programmable Oscilloscope Calibration Generator	398
CG 551AP	Programmable Oscilloscope Calibration Generator	398
CT-1	Current Transformer	449
CT-2	Current Transformer	449
CT-3	Signal Pickoff	449
CT-5	Current Transformer	449
C-28	Oscilloscope Camera	430
C-30B	Oscilloscope Camera	427
C-31B	Oscilloscope Camera	427
C-5C	Oscilloscope Camera	426
C-51	Oscilloscope Camera	428
C-53	Oscilloscope Camera	428
C-59A	Oscilloscope Camera	429
DAS 9109	Digital Analysis Mainframe	64-69
DAS 9119	Digital Analysis Mainframe (ATE Version)	64-69
DAS 9129	Color Digital Analysis Mainframe	64-69
DC 5009	Programmable 135 MHz Universal Counter/Timer	361
DC 5010	Programmable 350 MHz Universal Counter/Timer	360
DC 503A	125 MHz Universal Counter	375
DC 504A	100 MHz Counter/Timer	377
DC 509	135 MHz Universal Counter/Timer	375
DC 510	350 MHz Universal Counter/Timer	375
DD 501	Digital Delay	387
DF1	Display Formatter	79
DF2	Display Formatter	79
DL2	Digital Latch	79
DL 502	Digital Latch	389
DM 44	Digital Multimeter	322
DM 501A	Digital Multimeter	382
DM 5010	Programmable Digital Multimeter	363
DM 502A	Autoranging Digital Multimeter	383
DP 501	Digital Prescaler	363,376
FG 501A	2 MHz Function Generator	380
FG 5010	Programmable 20 MHz Function Generator	365
FG 502	11 MHz Function Generator	380
FG 503	3 MHz Function Generator	380
FG 504	40 MHz Function Generator	381
FG 504T	40 MHz Function Generator	381
FG 507	2 MHz Sweeping Function Generator	381
GMA102A	Computer Display Module	144
GMA103	Computer Display Module	144
GMA125	Large Screen Computer Display Module	145
J16	Digital Photometer/ Radiometer	417
J6501	Illuminance Probe	418
J6502	Irradiance Probe	418
J6503	8° Luminance Probe	418
J6504	Uncorrected Probe	419
J6505	LED Probe	419
J6511	Illuminance Probe	418
J6512	Irradiance Probe	418
J6523	1° Luminance Probe	418
MERLYN-G	Gate Array Layout System	114
MI 5010	Programmable Multifunction Interface	369
MX 5010	Interface Extender	369
M2	Sample/Hold Module	276
M4115B	Computer Display Terminal Workstation	104
OF150	Fiber Optic TDR	148
OS-245(P)/U	Ruggedized Oscilloscope	252
PG 501	50 MHz Pulse Generator	386
PG 502	250 MHz Pulse Generator	387
PG 506	Calibration Generator	400
PG 507	Dual Output 50 MHz Pulse Generator	386
PG 508	50 MHz Pulse Generator	386
PG 508T	50 MHz Pulse Generator	386
PLOT 10	Graphics Software Library	117
PLOT 50	Graphics Software Library	119
PM 101	Microproc Personality Module	81
PM 102	Microproc Personality Module	81
PM 103	Microproc Personality Module	81
PM 104	Microproc Personality Module	81
PM 105	Microproc Personality Module	81
PM 106	Microproc Personality Module	81
PM 107	Microproc Personality Module	81
PM 108	Microproc Personality Module	81
PM 109	Microproc Personality Module	81
PM 110	Microproc Personality Module	81
PM 111	Microproc Personality Module	81
PM 112	Microproc Personality Module	81
PMA 100	Personality Module Adaptor	81
PS 5004	Prgmbl Power Supply	366
PS 5010	Prgmbl Triple Power Supply	366
PS 501-1	Power Supply	389
PS 503A	Triple Power Supply	389
P6006	10X Probe	440
P6007	100X Probe	454
P6008	10X Probe	446
P6009	100X Probe	454
P6010	10X Probe	440
P6015	1000X Probe	454
P6021	Current Probe	448
P6022	Current Probe	448
P6028	1X Probe	440
P6046	FET Differential Probe	444
P6048	10X Probe	444
P6053B	10X Probe	455
P6055	10X Probe	455
P6056	10X Probe	444
P6057	100X Probe	444
P6062B	10X or 1X Probe	455
P6063B	10X or 1X Probe	455
P6101	1X Probe	452
P6104	Voltage Probe	439
P6105	10X Probe	452
P6106	10X Probe	452
P6107	10X Probe	453
P6108	10X Probe	452
P6121	10X Probe	451
P6122	10X Probe	451
P6125	5X Counter Probe	377
P6130	10X Probe	450
P6131	10X Probe	450
P6149	10X Probe	453
P6201	FET Probe	443
P6202A	FET Probe	443
P6230	10X Probe	442
P6302	Current Probe (See A6302)	447
P6303	Current Probe (See A6303)	447
P6401	Logic Probe	84,445
P6406	Word Recognizer Probe	439
P6420	1X RF Probe	446
P6430	Temperature Probe	439
P6451	Data Acquisition Probe	84
P6452	Data Acquisition Probe	84
P6453	High-Speed Data Acquisition Probe	84
P6454	100 MHz Clock Probe	84
P6455	TTL/MOS Pattern Generator Probe	84
P6456	ECL Pattern Generator Probe	84
P6457	Pattern Generator Probe	84
P6460	Data Acquisition Probe	84
P6462	Data Acquisition Probe	84
P6601	Temperature Probe	384
P6602	Temperature Probe	445
SC 501	5 MHz Oscilloscope	394
SC 502	15 MHz Dual Trace Oscilloscope	394, 397
SC 503	10 MHz Storage Oscilloscope	396
SC 504	80 MHz Oscilloscope	395
SG 502	RC Oscillator	401
SG 503	Leveled Sinewave Generator	401
SG 504	Leveled Sinewave Generator	401
SG 505	Oscillator	390
SG 5010	Programmable Oscillator	367
SI 5010	Programmable Scanner	372
SPG12	TV Sync Generator	189
SPG2	TV Sync Generator	189
SPG22	TV Sync Generator	189
S-1	Sampling Head	282
S-2	Sampling Head	282
S-3A	Sampling Head	282
S-3220	LSI Test System	90
S-3270	LSI Test System	92
S-3275	LSI/VLSI Test System	91
S-3280	ECL Test System	93
S-3295	VLSI Test System	89
S-4	Sampling Head	282
S-5	Sampling Head	282
S-6	Sampling Head	282
S-51	Trigger Countdown Head	283
S-52	Pulse Generator Head	283
S-53	Trigger Recognizer Head	283
S-54	Pulse Generator Head	283
TDC	TV Down Converter	203
TDC-1	TV Down Converter	203

Color identifies *NEW* products.

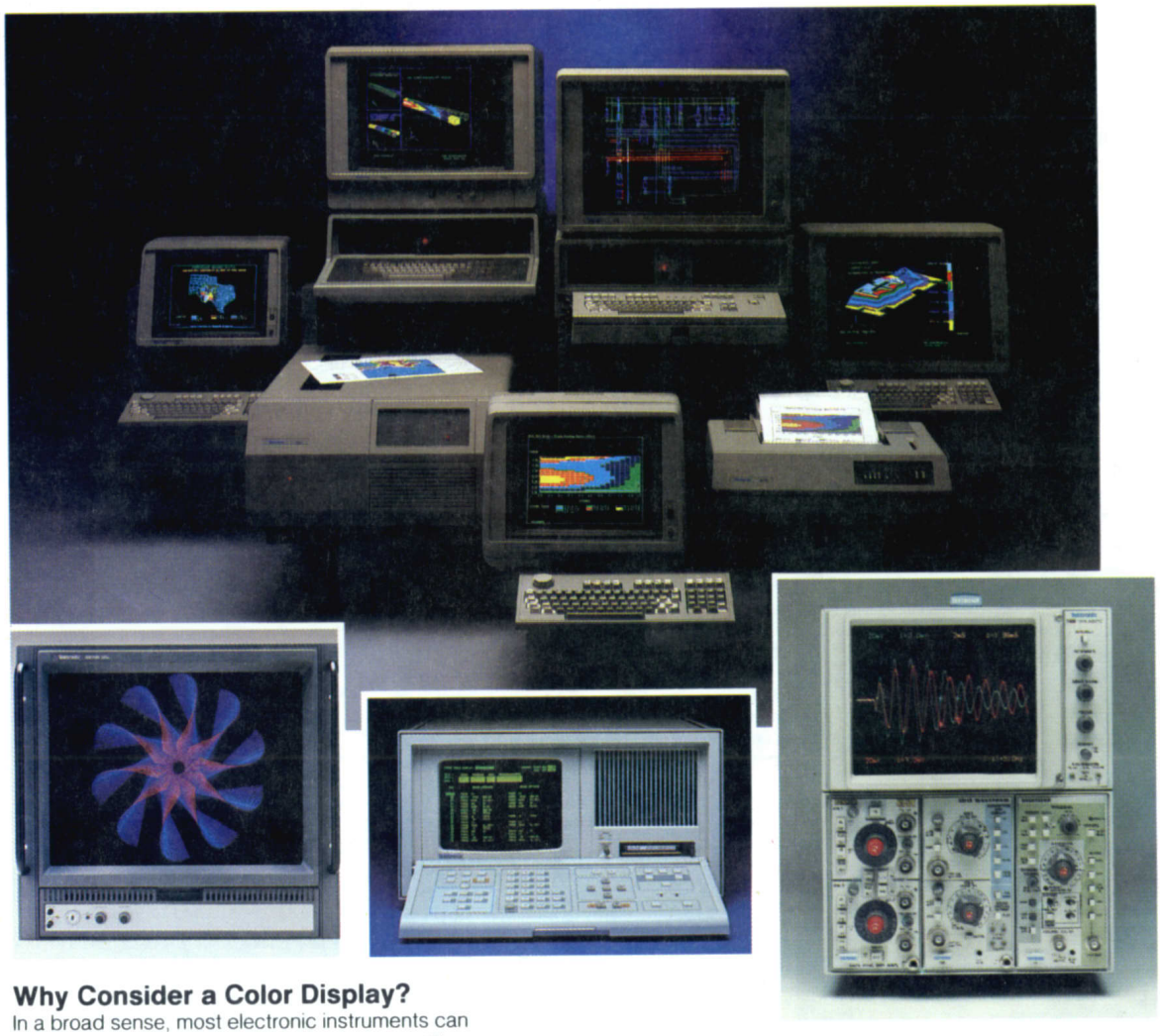
Type	Instrument Description	Page
TDC-2	TV Down Converter	203
TD-1085/U	Time Base Plug-In	252
TG 501	Time Mark Generator	400
TM 5003	Three-Wide Mainframe	402
TM 5006	Six-Wide Mainframe	402
TM 501	One-Wide Mainframe	402
TM 503	Three-Wide Mainframe	402
TM 504	Four-Wide Mainframe	402
TM 506,	Six-Wide Mainframes	402
RTM 506	Six-Wide Mainframes	402
TM 515	Five-Wide Mainframe	402
TR 502	Tracking Generators	223
TR 503	Tracking Generators	223
TSG11	TV Test Signal Generator	190
TSG12	TV Test Signal Generator	190
TSG13	TV Test Signal Generator	191
TSG15	TV Test Signal Generator	191
TSG16	TV Test Signal Generator	192
TSG2	TV Test Signal Generator	190
TSG21	TV Test Signal Generator	190
TSG23	TV Test Signal Generator	191
TSG25	TV Test Signal Generator	191
TSG26	TV Test Signal Generator	192
TSG3	TV Test Signal Generator	191
TSG5	TV Test Signal Generator	191
TSG6	TV Test Signal Generator	192
TSG7	TV Test Signal Generator	190
TSP1	TV Signal Processor	192
TSP11	TV Signal Processor	192
TSP21	TV Signal Processor	192
T912	10 MHz Dual Trace Storage Oscilloscope	326
T922R	15 MHz Rackmount Dual Trace Oscilloscope	319
WP Series	Waveform Processing Systems	353-357
XY1	Output Module	149
110-S	Synchronizer	162
1101	Probe Power Supply	443
1105	Battery Power Supply	313,405
1240	Logic Analyzer Mainframe	70
134	Current Probe Amplifier	448
1360P	Prgmbl Switch Controller	372
1360S	Switch Matrix	372
1405	TV Sideband Adaptor	224
1410	NTSC Mainframe	189
1411	PAL Mainframe	189
1412	PAL-M Mainframe	189
1420	TV Vectorscope	179
1421	TV Vectorscope	179
1422	TV Vectorscope	179
1424	X-Y Display Monitor	179
143, R143	SECAM TV Test Signal Generators	197
1430	TV Noise Measurement Set	201
1440	Automatic Video Corrector	202
1450-1	TV Demodulator Mainframe	203
1450-2	TV Demodulator Mainframe	203
1450-3	TV Demodulator Mainframe	203
147A,	TV Test Signal Generator	200
R147A	TV Test Signal Generator	200
1470	TV Test Signal Generator	196
1474	TV Sync Generator	196
148, R148	PAL TV Test Signal Generators	198
148-M, R148-M	PAL-M Test Signal Generators	198
1480C	TV Waveform Monitor	177
1480R	TV Waveform Monitor	177
1481C	TV Waveform Monitor	177
1481R	TV Waveform Monitor	177
1482C	TV Waveform Monitor	177
1482R	TV Waveform Monitor	177
1485C	TV Waveform Monitor	177
1485R	TV Waveform Monitor	177
1502, 1503	TDR Cable Testers	150
172	Programmable Test Fixture	410
1740	NTSC Wvfm/Vector Monitor	159
1741	PAL Wvfm/Vector Monitor	159
1742	PAL-M Wvfm/Vector Monitor	159
176	Pulsed High Current Fixture	411
177	Standard Test Fixture	412
178	Linear IC Test Fixture	414
1910	Digital Generator	164
1980	ANSWER (Automatic Video Measurement Set)	168
200C, 200D	SCOPE-MOBILE® Carts	431
205, 205D	SCOPE-MOBILE® Carts	431
206, 206D	SCOPE-MOBILE® Carts	432
212	500 kHz Dual Trace Portable Oscilloscope	318
213	1 MHz Portable Oscilloscope/DMM	317
214	500 kHz Dual Trace Portable Storage Oscilloscope	325
221	5 MHz Portable Oscilloscope	316
2213	60 MHz Dual Trace Portable Oscilloscope	310
2215	60 MHz Dual Trace Portable Oscilloscope	310
2235	100 MHz Dual Trace Portable Oscilloscope	308
2236	100 MHz Dual Trace Portable Oscilloscope	308
2335	100 MHz Dual Trace Portable Oscilloscope	306
2336	100 MHz Dual Trace Portable Oscilloscope	306
2337	100 MHz Dual Trace Portable Oscilloscope	306
2445	150 MHz Four Trace Portable Oscilloscope	303
2465	300 MHz Four Trace Portable Oscilloscope	303
284	Pulse Generator	387
3, 3D	TEK Lab Cart	432
305	5 MHz Dual Trace Portable Oscilloscope/DMM	315
308	Data Analyzer	75
314	10 MHz Dual Trace Portable Storage Oscilloscope	324
318	Logic Analyzer	76
335	35 MHz Dual Trace Portable Oscilloscope	314
336	50 MHz Dual Trace Portable Digital Storage Oscilloscope	352
338	Logic Analyzer	76
380	NTSC Portable Video Test Monitor	175
381	PAL Portable Video Test Monitor	175
390AD	Programmable Waveform Digitizer	342
4006-1	Computer Display Terminal	122
4012	Computer Display Terminal	122
4014-1	Computer Display Terminal	123
4016-1	Computer Display Terminal	124
4025A	Computer Display Terminal	125
4027A	Color Graphics Terminal	125
4041	System Controller	331
4051	Desktop Computer	128
4052A	Desktop Computer	129
4054A	Desktop Computer	130
4105	Computer Display Terminal	98
4107	Computer Display Terminal	99
4109	Computer Display Terminal	100
4112B	Computer Display Terminal	106
4113B	Computer Display Terminal	107
4113B30	Computer Display Terminal Workstation	107
4114B	Computer Display Terminal	108
4114B30	Computer Display Terminal Workstation	108
4115B	Computer Display Terminal	104
4116B	Computer Display Terminal	109
4116B30	Computer Display Terminal Workstation	109
4170	Local Graphics Processing Unit	101
434, R434	25 MHz Dual Trace Portable Storage Oscilloscopes	323
4611	Hard Copy Unit	133
4612	Video Hard Copy Unit	134
4631	Hard Copy Unit	133
4632	Video Hard Copy Unit	134
4634	Image Forming Module	135
4635	Imaging Recorder	139
464	100 MHz Portable Storage Oscilloscope	321
4643	Matrix Printer	135
465M	100 MHz Dual Trace Portable Oscilloscope	312
466	100 MHz Portable Storage Oscilloscope	321
4662 Opt 31	Interactive Digital Plotter	136
4663	Interactive Digital Plotter	137
4663S	Interactive Digital Plotter	137
468, R468	100 MHz Dual Trace Portable Digital Storage Oscilloscopes	350
4691	Color Graphics Copier	103
4695	Color Graphics Copier	102
485, R485	350 MHz Dual Trace Portable Oscilloscopes	301
4907	File Manager	131
4909	Multiuser File System	132
492	Spectrum Analyzer	211
492P	Programmable GPIB Spectrum Analyzer	211
4924	Digital Cartridge Tape Drive	131

Color identifies *NEW* products.

Type	Instrument Description	Page
4925	Dual Flexible Disk	110
4926	10 Megabyte Hard Disk	110
4932	GPIB Extender	132
4952	Joystick	138
4953	Graphic Tablet	138
4954, 4956	Graphic Tablets	138
4957	Graphic Tablet	138
496	Spectrum Analyzer	215
496P	Programmable GPIB Spectrum Analyzer	215
4970	Cluster Controller	111
5A13N	Differential Comparator Amplifier	295
5A14N	1 MHz Four Trace Amplifier	294
5A15N	2 MHz Amplifier	294
5A18N	2 MHz Dual Trace Amplifier	294
5A19N	Differential Amplifier	295
5A21N	Differential Amplifier/Current Probe Input	295
5A22N	Differential Amplifier	296
5A24N	2 MHz Amplifier	294
5A26	Dual Differential Amplifier	296
5A38	Dual Trace Amplifier	289
5A48	Dual Trace Amplifier	289
5B10N	Time Base/Amplifier	297
5B12N	Dual Delayed Sweep Time Base	297
5B25N	Digitizer Time Base	349
5B40	Time Base	289
5B42	Delaying Time Base	289
5CT1N	Curve Tracer Plug-in	415
5D10	Waveform Digitizer	293
5S14N	Dual Trace Sampling Unit	281,297
50M10	Programmable A/D Converter	370
50M20	Programmable D/A Converter	370
50M30	Programmable Digital Input/Output Card	371
50M40	Programmable Relay Scanner Card	371
50M41	Prgmbl Low-Level Scanner	369
50M50	Prgmbl Memory Card	370
50M70	Prgmbl Development Card	371
5110 R5110	2 MHz Single-Beam Oscilloscopes	291
5111A R5111A	2 MHz Single-Beam Storage Oscilloscopes	290
5113, R5113	2 MHz Dual-Beam Storage Oscilloscopes	291
5116	Color Storage Oscilloscope	292
520A R520A	TV Vectorscope TV Vectorscope	180 180
521A R521A	TV Vectorscope TV Vectorscope	180 180
522A R522A	TV Vectorscope TV Vectorscope	180 180
5223, R5223	10 MHz Digital Storage Oscilloscopes	348
528A	TV Waveform Monitor	179
5440 R5440	50 MHz Single-Beam Oscilloscope	287
5441 R5441	50 MHz Variable Persistence Storage Oscilloscope	288
576	Semiconductor Curve Tracer	408
577/D1	Storage Curve Tracer Mainframe	412
577/D2	Curve Tracer Mainframe	412
606B	General Purpose Waveform Monitor	142
608	High Brightness Display Monitor	143
614	Storage Display Monitor	127
616	Storage Display Monitor	127
618	Storage Display Monitor	127
620	General Purpose Waveform Monitor	142
624	Direct Viewing Display Monitor	143
634	Hi Resolution Video Monitor	141
650HR 650HR-1	TV Picture Monitor TV Picture Monitor	182 182
651HR 651HR-1	TV Picture Monitor TV Picture Monitor	182 182
652HR 652HR-1	TV Picture Monitor TV Picture Monitor	182 182
653HR 653HR-1	TV Picture Monitor TV Picture Monitor	184 184
655HR 655HR-1	TV Picture Monitor TV Picture Monitor	182 182
656HR 656HR-1	TV Picture Monitor TV Picture Monitor	184 184
69M01	NTSC Comb Decoder	185
69M10	PAL Decoder	185
69M41	RGB Interface Module	185
690SR	TV Picture Monitor	185
7A11	Single Trace Amplifier	265
7A13	Differential Comparator Amplifier	266
7A15A	Single Trace Amplifier	263
7A16A	Single Trace Amplifier	263
7A16P	Programmable Amplifier	345,347
7A17	Single Trace Amplifier	265
7A18A	Dual Trace Amplifier	264
7A19	Single Trace Amplifier	263
7A22	Differential Amplifier	267
7A24	Dual Trace Amplifier	264
7A26	Dual Trace Amplifier	264
7A29	Dual Trace Amplifier	263
7A42	Logic Triggered Vert Amp	268
7B10	Time Base	272
7B15	ΔDelaying Time Base	272
7B50A	Time Base	273
7B53A	Dual Time Base	273
7B80	Time Base	270
7B85	ΔDelaying Time Base	270
7B87	Time Base w/Pretrigger Acquire Clock	270
7B90P	Programmable Time Base	347
7B92A	Dual Time Base	271
7CT1N	Curve Tracer Plug-in	415
7D01, 7D01F	Logic Analyzers	79
7D01F2	Logic Analyzer	79
7D02	Logic Analyzer	80
7D11	Digital Delay	274
7D12	A/D Converter	276
7D13A	Digital Multimeter	276
7D15	Universal Counter/Timer	275
7D20, 7D20T	Programmable Digitizers	337
7K11	CATV Preamplifier	224
7L12	Spectrum Analyzer	219
7L14	Spectrum Analyzer	218
7L18	Spectrum Analyzer	217
7L5	Spectrum Analyzer	221
7M11	Dual 50 Ω Delay Line	280
7M13	Readout Unit	267
7S11	Sampling Unit	280
7S12	TDR/Sampler	279
7S14	Dual Trace Delayed Sweep Sampler	281
7T11	Sampling Sweep Unit	280
7104	1 GHz Real-Time Oscilloscope	244
7603, R7603	100 MHz Oscilloscopes	250
7603N11S	Ruggedized Oscilloscope System	252
7612D	200 MHz Programmable Waveform Digitizer	344
7613, R7613	Variable Persistence Storage Oscilloscopes	260
7623A R7623A	Multimode Strg Oscilloscope Multimode Strg Oscilloscope	258 258
7633 R7633	Multimode Strg Oscilloscope Multimode Strg Oscilloscope	258 258
7704A R7704	250 MHz Oscilloscope 250 MHz Oscilloscope	248 248
7834	Fast Storage Oscilloscope	256
7844, R7844	400 MHz Dual-Beam Oscilloscope	254
7854	400 MHz Waveform Processing Oscilloscope	340
7904A R7903	500 MHz Oscilloscopes 500 MHz Oscilloscopes	246 246
7912AD	Programmable Transient Waveform Digitizer	346
834	Prgmbl Data Comm Tester	153
834RDA	ROM Pack Development Aid	154
834R01	General Purpose ROM Pack	154
834R02A	Bisynchronous ROM Pack	154
834R03A	Link Test ROM Pack	154
834R04	HDLC/X-25 ROM Pack	154
834R05	Extended Instruction Set ROM Pack	154
834R06	Bisynchronous ROM Pack	154
834R07	PARS/IPARS ROM Pack	154
834R10	SDLC/SNA ROM Pack	154
834R11	Extended Monitor ROM Pk	154
834R13	SDLC/SNA ROM Pack	154
851	Digital Tester	158
8540	Microcomputer Integration Unit	45
8550	Microcomputer Development Lab	45
8560	Multiuser Microcomputer Development Lab	45
8561	Multiuser Software Development Unit	57
91AE04A	Data Acquisition Module	67
91A04A	Data Acquisition Module	67
91A08	Data Acquisition Module	66
91A24	Data Acquisition Module	66
91AE24	Data Acquisition Module	66
91A32	Data Acquisition Module	66
91P16	Pattern Generator Module	67
91P32	Pattern Generator Module	67

Color identifies *NEW* products.

Expanded Color Spectrum



Why Consider a Color Display?

In a broad sense, most electronic instruments can be classified as information display systems. That is, they interact with a user to gain input information and then present output information for the user's benefit. Such systems range from graphic display systems through oscilloscopes and logic analyzers to simple voltmeters. No matter how sophisticated the system, its ultimate usefulness depends upon the ease of the information transfer between operator and device. A flickering display, a complex programming requirement, or a hard-to-read analog dial all create less than optimum conditions for information transfer. The most successful display devices and techniques will be the ones that, while meeting the performance and reliability needs, provide the friendliest interface for the user and minimize all factors causing fatigue. Operator comfort, which includes ease of use and friendliness, is one of the most important parameters to be met.

Human factors engineering, or ergonomics, optimizes such information display systems. Here, we consider one particular aid to information transfer, color.

The case for color as an effective display vehicle has received strong support through research by both government and private industry. These studies have helped build a strong consensus regarding color's optimum application in almost any instrument environment.

Color Perception

The physiological fact behind color's continued success in visual displays is that the brain has two separate channels for processing visual information: one chromatic, the other achromatic. In many instances, data from both processing channels is used to interpret the meaning of an image. An achromatic display deprives the operator of one entire visual data channel. Without this chromatic data flow, the brain's processing power is reduced, especially when interpreting complex visual information. The use of color substantially improves the readability of electronic instrument displays.

Color, as applied to an instrument's display format, overcomes a number of the limitations of the cumbersome coding techniques developed for use on monochromatic displays. It is particularly beneficial when viewing a complex display with high information density.

First, color can be used to organize information into logical groupings that will best serve the interests of the user. For instance, high-priority items can be coded one color and low-priority items another.

Second, color can be used to locate information. This technique is especially useful when small but important items might be visually lost in a mass of other information.

Third, color can attract attention. Finding a single element in a complex array is easy when a color difference exists. A specific color can be associated with a particular class of events, such as red for warning or yellow for critical information. Color also allows a single instrument to function in a number of different modes with a particular color unambiguously signaling the mode.

Fourth, color definitely has a high aesthetic appeal which serves to reduce the monotony of prolonged display viewing. Although only subjective reports substantiate this aspect, color appears to enhance productivity by reducing boredom and fatigue.

The proper use of color can improve the functionality of an instrument in both the perceptual and cognitive domains. Further, color can enhance the discriminability between simultaneous events; their separation is easiest when color is used to distinguish them. Another perceptual aspect is the relative permanence of colors. Although the exact hue may change slightly as illumination or observer adaptation changes, red still remains red. This is not true of achromatic luminance (gray levels), which may appear substantially different under different lighting.

Ergonomics of Color

Through technical improvements and cost reductions, color has now become a potentially powerful tool for improving the instrument/user interface. Yet, as is often the case, the misuse of color can serve to render the interface more difficult instead of easier. As a general principle, one should use what is known about color to enhance the interface (rather than use color because it happens to be technically feasible). Not all systems will benefit from color.

First, it should be emphasized that color is a product of human perception, the result of a human eye reacting to "visible" wavelengths of electromagnetic radiation. The optical and sensory mechanics of the eye give color its three basic qualities:

Hue, which identifies the color in relation to other colors in the spectrum, such as red, yellow, green, etc.

Saturation, which defines the "purity" of color. As spectral colors become less pure, they appear more gray or white.

Lightness, which refers to the relative strength of the light coming from the color, as perceived by the observer.

As the wavelengths of visible light change, the human eye perceives a changing hue that produces the familiar spectral colors, ranging from deep red through yellow, green, and blue to purple. At any given wavelength, a "pure" color is produced that yields maximum saturation. Pure colors can be desaturated by increasing lightness until the color is "washed out".

The distribution and saturation of colors both play an important part in human color perception. Colors widely separated in the spectrum, such as red and green, are much easier to discriminate than neighboring colors. Also, "grayish" colors of low saturation become difficult to separate. On the other hand, highly saturated colors that are also widely separated in hue require the eye to refocus, which can be a source of fatigue. Another important consideration is that the eye's foveal region, which yields maximum visual resolution, is essentially "blind" to the color blue, making it a poor choice for presenting detailed information.

Color Display Technology

The CRT is the most important factor in determining what characteristics a color display will have. Tektronix color display technology produces three basic types of CRTs: the Direct-View Storage Tube, the shadow-mask CRT, and the liquid-crystal (LC) CRT System. The choice of CRT and display system is determined by the user's needs and application. For any particular color display application, the user is concerned with image quality and information handling capability relative to that application.

Direct-View Storage Tube

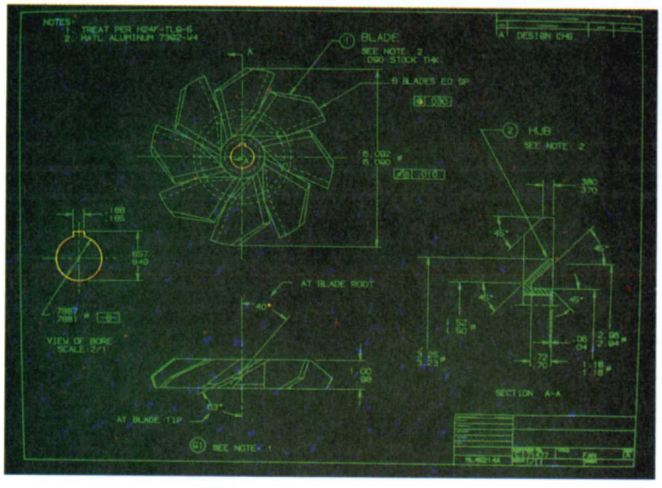
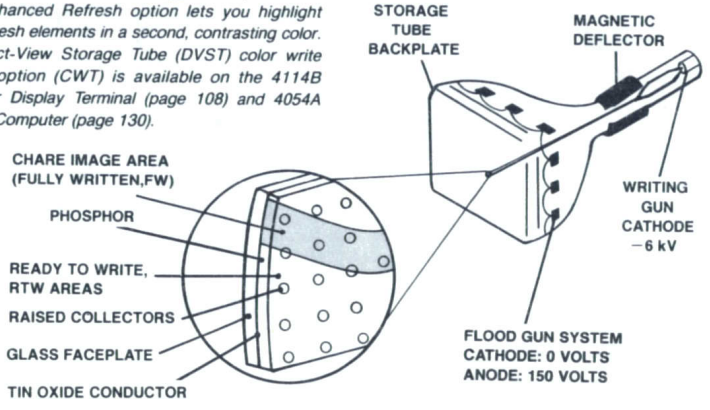


Figure 1. Frequently used symbols, as in this mechanical engineering diagram, can be recalled as needed, scaled, rotated and dragged into place. The Color Enhanced Refresh option lets you highlight these refresh elements in a second, contrasting color. The Direct-View Storage Tube (DVST) color write through option (CWT) is available on the 4114B Computer Display Terminal (page 108) and 4054A Desktop Computer (page 130).



The DVST shown in Figure 1, consists of a writing gun that operates at a large negative potential with respect to the target, an array of low-energy flood guns, and a special phosphor target. The phosphor is separated from a transparent conductor by an insulating layer with an array of conductive dots. The phosphor is a composite mixture of two phosphors—the normal green for storage and a red phosphor with a dead layer surrounding it.

When the DVST is set to the storage mode, green vectors are stored on the screen (vector storage). The flood guns maintain the image on the display surface, so there is no need to continually redraw the image. There is no flicker, no matter how many vectors are drawn.

A separate local memory allows objects to be created and repeatedly retraced to produce a nonstored image on the screen (refresh mode). The nonstored image is retraced fast enough so that the viewer perceives a constant image.

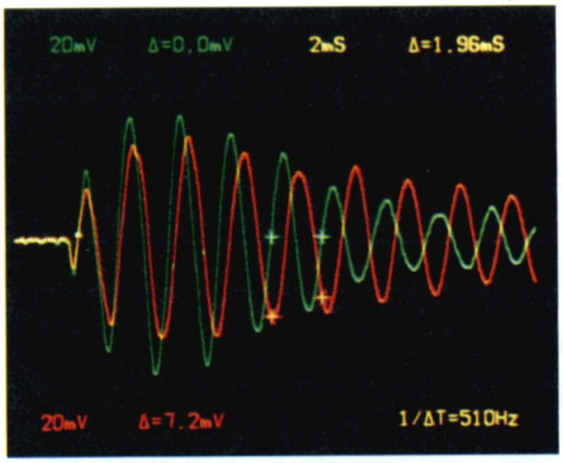
This feature allows images to be moved around the screen before storing or to be selectively erased without having to redraw the entire picture. Since the memory is essentially independent of the stored image circuitry, both stored and refreshed information can be displayed simultaneously.

It is not always easy to distinguish between refreshed and stored images on the screen of a DVST without CWT. Both images are displayed in a similar shade of green. Generally, the operator adjusts the writing beam intensity so that refreshed images appear dimmer than stored images. This method, however, sacrifices some brightness to gain differentiation.

With CWT, images of another color can be added to the display. When the write beam is operated with reduced current to prevent storage, a yellowish-orange spot is produced on the screen. This nonstored spot can then be deflected in a refresh vector mode (color refresh).

Color refresh not only increases the perceived brightness of images, but also introduces a color contrast between those parts of a picture displayed in refresh mode and those displayed in storage mode. The operator determines at a glance which segments in a displayed picture can be dynamically modified.

Liquid-Crystal Color Display (The Color Shutter)



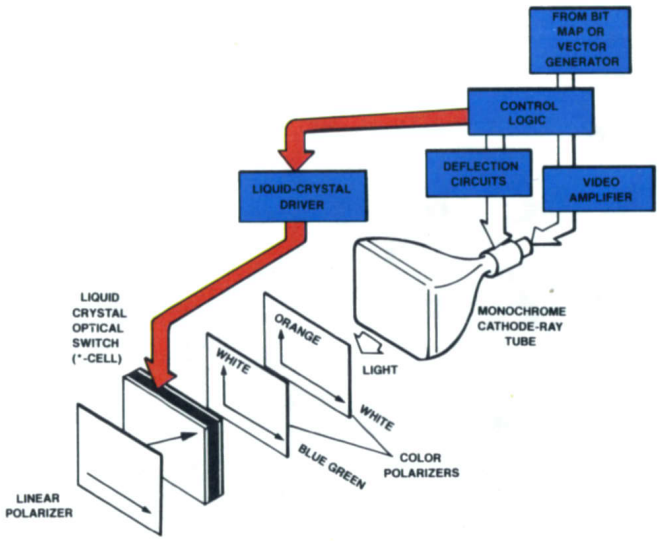


Figure 2. Control logic drives a liquid-crystal switch that, by twisting light coming through two filters, lets the linear polarizer filter out emissions from a monochrome CRT. The eye integrates them into orange, blue-green, or an in-between yellow according to the area written on the screen, as shown at left.

An entirely new method of producing color displays without shadow masks, color-dot phosphors, or any of the other usual techniques has been developed by Tektronix. Based on a combination of liquid-crystal and cathode-ray tube technologies, this LC/CRT system (shown in Figure 2) combines a black and white or "monochrome" CRT and a liquid-crystal "color shutter" to produce a very-high-resolution, field-sequential color display. Functioning as a color shutter, this very fast switching device fits in front of the CRT face, thus making it practical to build high-resolution color displays into oscilloscopes and other display instruments. Because no shadow mask or patterned phosphors are used, the resolution can be as high as any monochrome CRT. This is a particular advantage in small display sizes where high-resolution color has not been practical before.

The "monochrome" CRT employed has a simple phosphor with two separate emission peaks that are orange and blue-green. The phosphor does not require any special process steps. However, the true "state-of-the-art" advance represented by the color shutter is the liquid-crystal shutter itself, which provides a three-color display (orange, blue-green, and neutral) of excellent crispness, detail, and color purity. On the new 5116 Color Oscilloscope, the LC shutter is basically a sandwich consisting of a color polarizer, a variable-retardation liquid-crystal cell, and a linear polarizer. The LC shutter consists of two glass plates coated with indium tin oxide for the transparent conductor, a thin layer of silicon dioxide for an insulator, and a special "alignment" layer that causes the director (essentially the major axis of the liquid crystal) to tilt in the same direction on both surfaces.

Field-Sequential System

Previous efforts to produce a field-sequential system have suffered from the lack of a suitably fast color shutter. Earlier attempts at fabricating LC color shutters have used simple twisted nematic (liquid crystal) devices or dual-frequency nematic devices. The simple LC devices generally have relaxation times (essentially the time to switch from one polarization state to another) that are much longer than several milliseconds and are not suitable for fast switching applications. Flicker-free operation of a sequential two-primary-color display requires field rates of 120 Hz, for example, which in turn requires LC shutters capable of millisecond transition times for both the on and off states. Dual-frequency devices can have sufficiently fast response but require the use of drivers that must deliver a high-frequency signal into a large capacitive load.

Employing a field-sequential system with displays having cells switched at a single frequency overcomes the need for high-voltage switching, a drawback of the dual-frequency cell approach. Typical dual-frequency cells are turned on with a low-frequency burst and turned off with a high-frequency signal, while the variable-retardation cell's elements are controlled by a single frequency. As a result the driving waveforms are simpler, and the driver's power requirements are less.

In any one field the information written on the screen appears only in the color selected by the LC shutter. The field-sequential system can provide all possible mixtures of the two primary colors contained in the phosphor. Each color or information field is displayed at a 60-Hz repetition rate.

The Pi Cell

The variable-retardation cell (called a pi cell) is sandwiched between a set of red and green color polarizers and a linear polarizer at the output, and its axis tilted 45 degrees with respect to the polarizers. The color polarizer orthogonally polarizes the orange and blue-green components of the CRT's emission, and the pi cell is used to sequentially rotate the polarized orange and blue-green information into the transmission axis of the linear polarizer. Rotation of the orange and blue-green information is performed in synchronization with the fields of the sequentially addressed CRT. Alternate fields, viewed through different colored polarizing filters, are integrated by the eye to give color images. By varying the Z-axis modulation, the full range of colors that lie along the line connecting the orange and blue-green peaks of the phosphor's emission spectrum on the chromaticity diagram can be achieved.

The pi cell derives its name from the pi-radian amount of twist it assumes in its quiescent or undriven state. Its features are achieved by speeding the relaxation time of an already fast untwisted birefringent variable-retardation cell, whose liquid-crystal elements are homogeneously aligned.

The on-to-off response time of the single liquid-crystal filter is equal to or better than that of a two-frequency arrangement under similar driving characteristics.

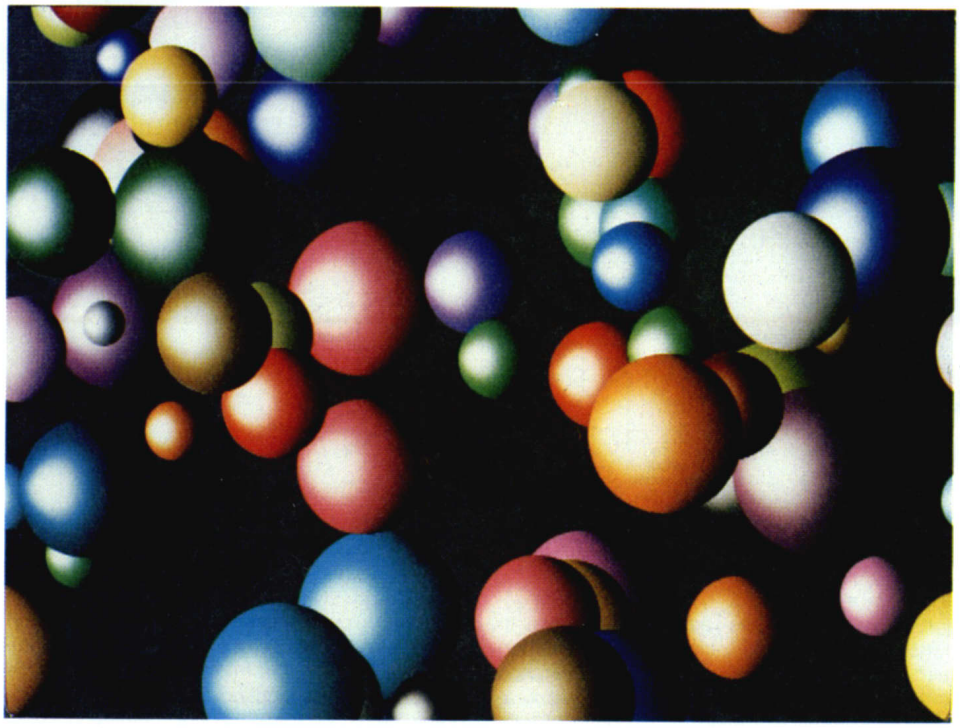
It is advantageous to keep the cell as thin as possible, since this results in a large angle of view, but narrowing the cell too much prevents achievement of the full half-wave retardation that is required. For LC shutters, such as used in our new 5116 Oscilloscope, there is no perceptible color shift over the normal viewing angle.

High Resolution, High Contrast

Among the LC/CRT system's advantages are high resolution over a wider range of display sizes, good contrast in high ambient light, and ruggedness, due to the absence of special shadow-mask and phosphor arrangements or complex electron guns. The LC color shutter can be used in either vector or raster displays.

The combination of the color shutter and either a diffusing or an antireflection coated front surface can yield contrast ratios of better than 20:1 in the high ambient lighting normally found in today's offices. Since all screen writing is accomplished by a single electron beam, rather than by three beams as in a shadow-mask display, the LC shutter does not have misconvergence problems. This enhances resolution and produces a very readable display of text and complex graphics.

Shadow-Mask CRT



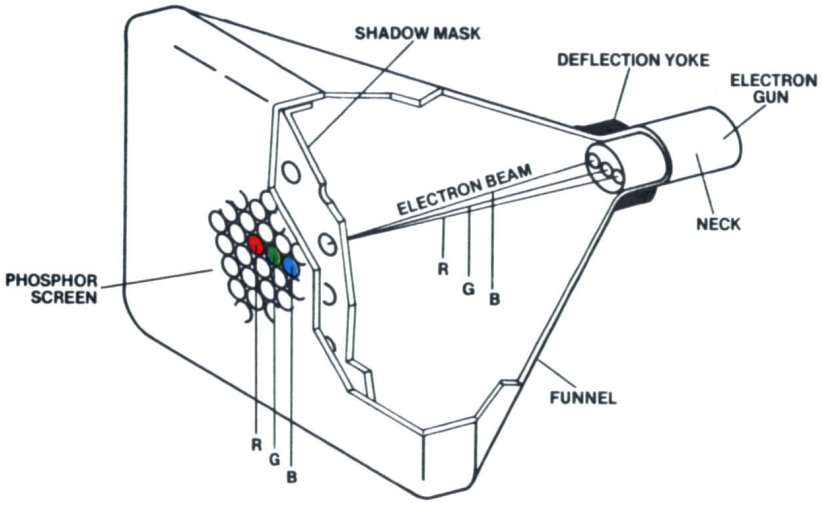


Figure 3.

The shadow-mask CRT illustrated in Figure 3 is the most commonly used type of CRT for color displays of all types. In fact, the shadow-mask CRT is the type used for home television and for studio television picture monitors. Usually, three electron guns are used to address three primary color phosphor dots or stripes. The dots are spaced close enough so that they appear to the eye as one. Colors other than the three primary colors result from proportional mixtures of the individual dots. A shadow mask is used to make sure that each beam addresses only its assigned color dot. The beams from the red, green, and blue guns must pass through the mask openings at the proper angles to strike their corresponding phosphor dots.

The three beams are deflected together over the phosphor screen in a raster pattern. In some systems the raster lines are scanned using the noninterlaced method (Figure 4). In other systems (e.g., home television), an interlaced raster is used. An interlaced display scans every other line in the first pass from top to bottom, then returns to the top and scans the intermediate lines in the next pass. A color image is drawn on the screen by the display system, which determines when each of the three electron guns receives current, and how much, and thereby how much of each color is produced at each point (pixel) on the screen.

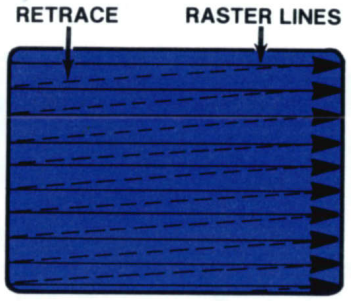


Figure 4.

When a shadow-mask CRT is used in graphics applications, a bit-map memory is used to store the image. The pixel information from the bit map is read out to the three electron guns in synchronism with the raster pattern of the beams. To produce an image on the CRT screen, the desired vectors and other shapes must first be converted into the proper pixels in the bit map using a scan conversion process. Algorithms are used to code the various shapes into several digital bits, representing the brightness desired at each pixel location on the screen.

Information in the bit map must be read out repeatedly to the CRT at a rate fast enough to avoid flicker. Therefore, the time required to change images on the screen is determined by how fast the scan conversion process can reload the bit map. The larger the bit map, the slower the reloading process; thus, raster images with a large number of pixels must trade off speed of interaction. As the number of pixels increases, so does the rate at which information is clocked out of the bit map. The deflection speed of the CRT beam and the bandwidth of the CRT video amplifier must increase accordingly. Deflection speed and video amplifier bandwidth ultimately limit the number of pixels possible.

Versatile Color Picture Monitors

Many color picture monitors are developed for use in a specific system with monitor design parameters chosen to optimize the overall performance of that system. The 690SR Color Picture Monitor Series covers a wide range of end use applications and, as such, its design provides a high degree of versatility and configurability. Versatility is inherent in the 690SR's scanning systems, which can operate over a wide range of rates, allowing excellent performance with most raster display formats. Configurability is provided by plug-in interface modules, allowing operation on standard encoded color television signals in the NTSC and PAL systems, and by an RGB interface module which supports the mainframe's scan rate capability.

The key element in a high-resolution color monitor is a high-resolution CRT with efficient phosphors which permits the use of relatively high brightness levels without sacrificing picture quality. The push toward higher resolution has resulted in phosphor element spacing evolving to 0.31 mm or less compared with 0.6 mm to 0.8 mm for home television picture tubes. The 690SR uses a delta-gun, dot-shadow-mask CRT with an extremely fine shadow-mask structure. There are approximately 1800 phosphor dots vertically and 1400 horizontally for each of the three colors in the CRT screen.

For applications where the operator must be close to the viewing surface, the fine screen produces a more pleasing display than a medium-resolution screen. However, for greater viewing distances a medium-resolution CRT provides adequate fineness and better screen uniformity.

Pure White
One of the major concerns in a television program production is that the color temperature of "white" be set accurately and maintained throughout the production. Changes in white balance cause unnatural colors to appear.

To reduce the need for white-balance adjustment, the 690SR employs beam-current feedback to offset changes in the CRT bias characteristics. Carefully designed video circuits ensure that tracking errors (relative changes in video gain between red, blue, and green channels) are held to less than two percent. The 690SR reduces the white-balance adjustments to the level of routine maintenance. Such stability ensures that if a problem is visible during critical viewing of a television production, it is not likely to be in the picture monitor.

A Spectrum of Performance Options
To provide a more optimum solution in diverse applications the 690SR has four different CRTs available, two with 0.31 mm pitch (phosphor element spacing) and two with a 0.43 mm pitch.

The combination of this choice of CRTs and the inherent versatility of the 690SR mainframe provides high-performance color raster displays for a wide variety of applications.

Best Resolution and Light Output
The 690SR standard CRT is a fine-screen, high-resolution, delta-gun, dot-matrix type. The phosphor is Matsushita's "standard" set with medium-short persistence. This tube has a polished faceplate and is suitable for applications where light output and resolution are primary considerations, including most nontelevision and some standard television requirements.

Medium Resolution, Controlled Colorimetry
The Option 25 CRT has 0.43 mm pitch, a medium-short persistence, and a polished faceplate. There are two advantages of the medium-resolution screens: better uniformity of light output over the area of the screen, and controlled phosphor colorimetry. (As the size of the phosphor dot decreases, the grain size of the phosphor becomes significant, and tolerances on the colorimetry of emitted light cannot be as closely controlled.)

The Option 25 CRT is particularly suited to television applications using the NTSC system and to other applications which have similiar colorimetric requirements. Primary application is in United States television environments where tight colorimetry specifications and uniformity of light output over the entire screen are a primary consideration and resolution requirements are not high.

Medium-Resolution, EBU Colorimetry
This is the same as Option 25 except that the colorimetry is designed to meet EBU (European Broadcast Union) requirements. It has close tolerances on the colors specified by the EBU. This CRT is particularly suited to PAL system applications and other environments where the largest color range is desired.

High Resolution and Reduced Flicker
The Option 26 CRT provides high resolution with longer persistence in the green and red phosphors. This minimizes flicker of the display, and is particularly useful when presenting alphanumerics or line graphics in an interlaced format. Option 26 also has an etched faceplate to minimize reflections. These characteristics are used for interlaced nontelevision systems and other applications where the primary consideration is minimum flicker. Unavoidable trade-offs include lower light output and some loss of resolution.

Color Display Characteristics

Image quality and information handling capability are the two broad categories of characteristics that are important to users of color displays. Image quality includes optical characteristics like resolution, edge sharpness, brightness, contrast, and color quality. Environmental "noise" can cause undesirable optical characteristics of displays, such as flicker, jaggies, and moire patterns. Information handling capability includes characteristics like display size, number of vectors or pixels, and number of colors.

Resolution
The quality of the image is strongly affected by the resolution of the display system. However, the term resolution is often used synonymously with the number of scan lines (addressability) in discussions of raster displays. Resolution refers to the display's ability to resolve or separate two closely spaced points, lines, or spatial frequencies. Resolution is the essential characteristic that determines image sharpness. The resolution of a display comprises a combination of elements including spot size, spot profile, dot spacing, number of scan lines and bandwidth. Addressability, on the other hand, refers to the display's ability to position lines or pixels anywhere on the screen. A display may have addressability that exceeds its resolution capability and so will not affect the resolution of the display. However, if the addressability is not high enough, it will affect the resolution of the display in complex images.

Color Quality Characteristics
Quality of color includes brightness, contrast, purity, and convergence.

Both the DVST with CWT and shadow-mask types of color displays reflect and scatter about the same amount of room light, so display contrast is determined by trace brightness. Display contrast can be improved by placing a filter in front of the display screen that will attenuate the emitted light less than the reflected light, which must make a double pass through the filter. Selective filters are also used to absorb room light while transmitting the emitted light from the display. Antiglare screens, which have either a special coating on the front surface or a matte finish to prevent specular reflections, are also used to improve display contrast.

Color Purity and Convergence
Color purity generally refers to the uniformity that a color has over a large area of the display screen. Purity is a measure of whether or not the primary colors selected by the individual beams are spectrally pure. If some electrons meant for the red dot impinge upon the green dot, then the primary color is not pure. Purity is not really much of a problem with the DVST/CWT but is typically a problem in shadow-mask CRT displays. Each of the three beams should excite the entire phosphor dot when the beams pass through the shadow-mask holes properly.

Convergence, on the other hand, is a measure of whether or not each primary color image is in perfect registration. Convergence usually varies over the area of the display screen. Convergence is not really a problem with the DVST/CWT displays. Misconvergence in shadow-mask CRT raster displays results because the three color beams pass through the deflection yoke differently and are exposed to slightly different deflection fields. Misconvergence is a nonlinear function of the deflection current and is difficult to eliminate, so compromise is usually accepted. Both static and dynamic convergence must be periodically adjusted because of circuit drifts, etc.

Autoconvergence
The new 4115B Computer Display Terminal contains a first-of-its-kind convergence feature that automatically corrects the natural drift occurring in the convergence of the color raster writing beams. Convergence is controlled to within 0.2 mm over the entire display area, resulting in sharper characters, lines, and colors. Technical skills are not required to maintain optimum convergence.

Logic Analysis

These complex, high-density displays are more readily comprehended when viewed in color. The DAS 9129 Digital Analysis System display is coded in red, green, and yellow. The use of these phosphors (instead of the usual red, green and blue) minimizes the effects of misconvergence (each character uses only one phosphor) while allowing the user to concentrate on high priority information displayed in yellow, or error messages displayed in red, as opposed to the quieter background information shown in green.

Information Handling Characteristics

Size
The ultimate size for color displays using DVSTs and shadow-mask CRTs is about 636 mm (25 inches) diagonally. The DVST can also be made quite small (152 mm or 6 inches) and still provide a large number of vectors because the spot size can be scaled down accordingly. The number of vectors in the color refresh mode is not limited by the resolution, but by the deflection speed required to write the vectors at a flicker-free rate. To display a large number of vectors, the deflection system must have a very high bandwidth, usually at the expense of power. However, the DVST avoids the need for high power with large numbers of stored vectors, though it faces the same trade-off for the refreshed color vectors.

Number of Colors
The DVST with CWT has a maximum of three colors. Only the shadow-mask CRT offers a full range of colors. The color capabilities of a shadow-mask CRT are usually determined by the choice of phosphors for the three primary colors.

The DVST with CWT is very useful where complex images are to be displayed and color is needed only to highlight areas of the display. The shadow-mask raster display is by far the most prevalent type of color display in use today.

Color Specification

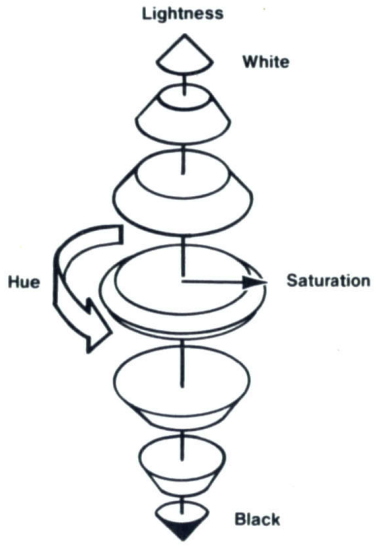


Figure 5. The double-ended cone can be used to express colors in terms of hue, lightness, and saturation. Hue is expressed in degrees from 0 to 360, lightness from 0 to 100%, and saturation from 0 to 100%.

An attractive feature of a color terminal is its ability to display images in the desired colors. But how does one go about selecting a specific color and describing it to a terminal in meaningful, precise terms? Interactively, the user specifies a color and the terminal displays it. The user evaluates the displayed color and corrects it if necessary. To be effective and expedient the method of describing colors must ease this interactivity.

There are many theories and models for specifying colors. One text alone shows over 30 approaches. Colors for Tektronix terminals are specified using the double-ended cone shown in Figure 5. Colors are selected by specifying hue, lightness, and saturation (HLS). These attributes relate to how colors are perceived. Hue is the characteristic associated with a color name such as red, yellow, or green. Lightness is the characteristic that allows the color to be ranked on a scale from dark to light. Saturation is the extent to which the color differs from a gray of the same lightness. For example, fire-engine red is highly saturated.

Lightness variations are represented along the vertical axis, with black at 0 percent at the bottom apex and white at the top at 100 percent. On a plane that intersects the cone perpendicularly to the vertical axis, all colors are of equal lightness. Variations in saturation are represented by a radial distance from the lightness axis. Hue is represented as an angular displacement around a circle intersecting the cone.

Stated quantitatively, hue is a variation of color advanced by degrees represented as an angle from 0° to 360° from a reference where 0° is blue.

Saturation is expressed as a percentage of the distance to the surface of the cone ranging from 0%, maximum white at that lightness level, to 100%, which is fully saturated.

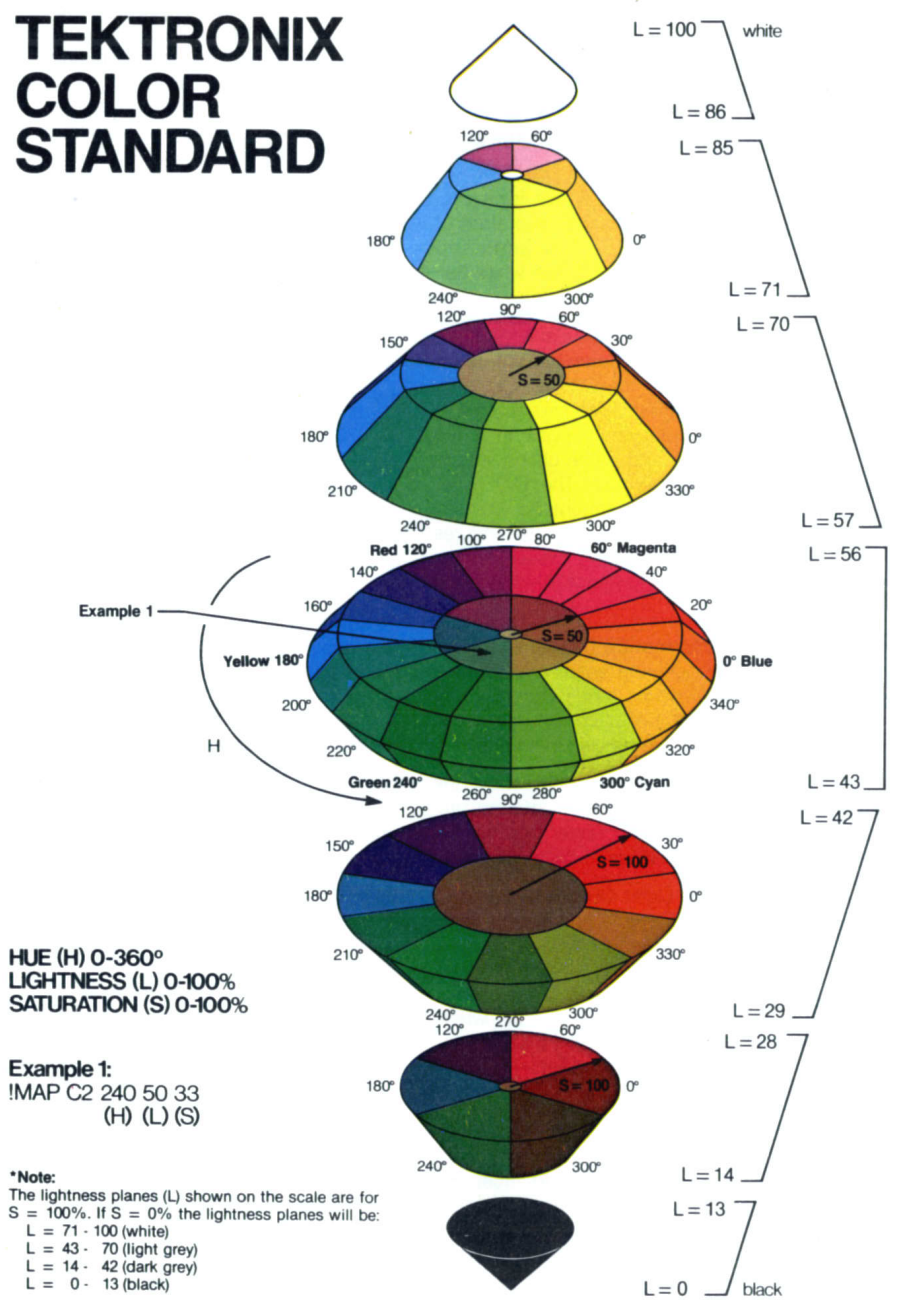
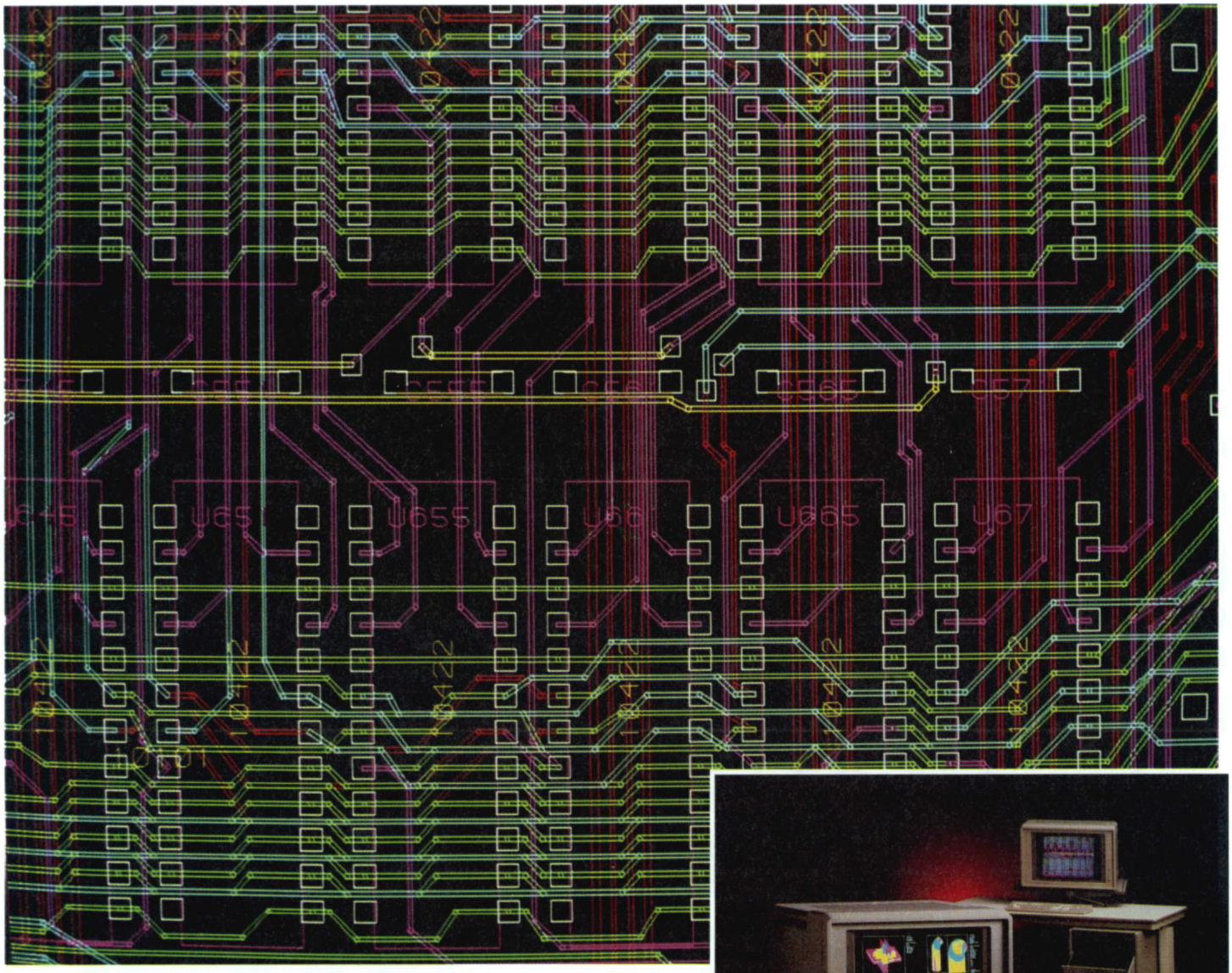


Figure 6. Tek Color Standard is one implementation of the double-ended cone concept. It is relatively easy to specify a desired color in terms of hue, lightness, and saturation using such a standard.

The Tektronix HLS color standard for a graphics terminal with a 64-color palette (Figure 6) illustrates the implementation of the double-ended cone. The continuous and theoretically infinite cone has been partitioned into 64 regions of color. Figure 6 can be used to illustrate the concept of specifying color. For example, fire-engine red can be specified as: hue is red (120°), lightness is 50%, and saturation is full (100%). This color would be specified as 120, 50, 100.

The HLS method of specifying color provides terminology and a conceptual framework for working with color. Because the cone and input numbers are easily learned and remembered, users are able to select a color from the color cone and display it close to the desired color on the first try. After evaluating the color they can easily change hue, lightness, and saturation as needed. Yet, increases in the numbers of obtainable colors on a display will demand alternative means of color specification. The HLS system has 3.6 million color addresses (360 x 100 x 100) while the 4115B has 16 million color addresses (eight bits per gun). Ongoing research at Tektronix seeks to enhance the interface to color beyond today's standard set by Tektronix.

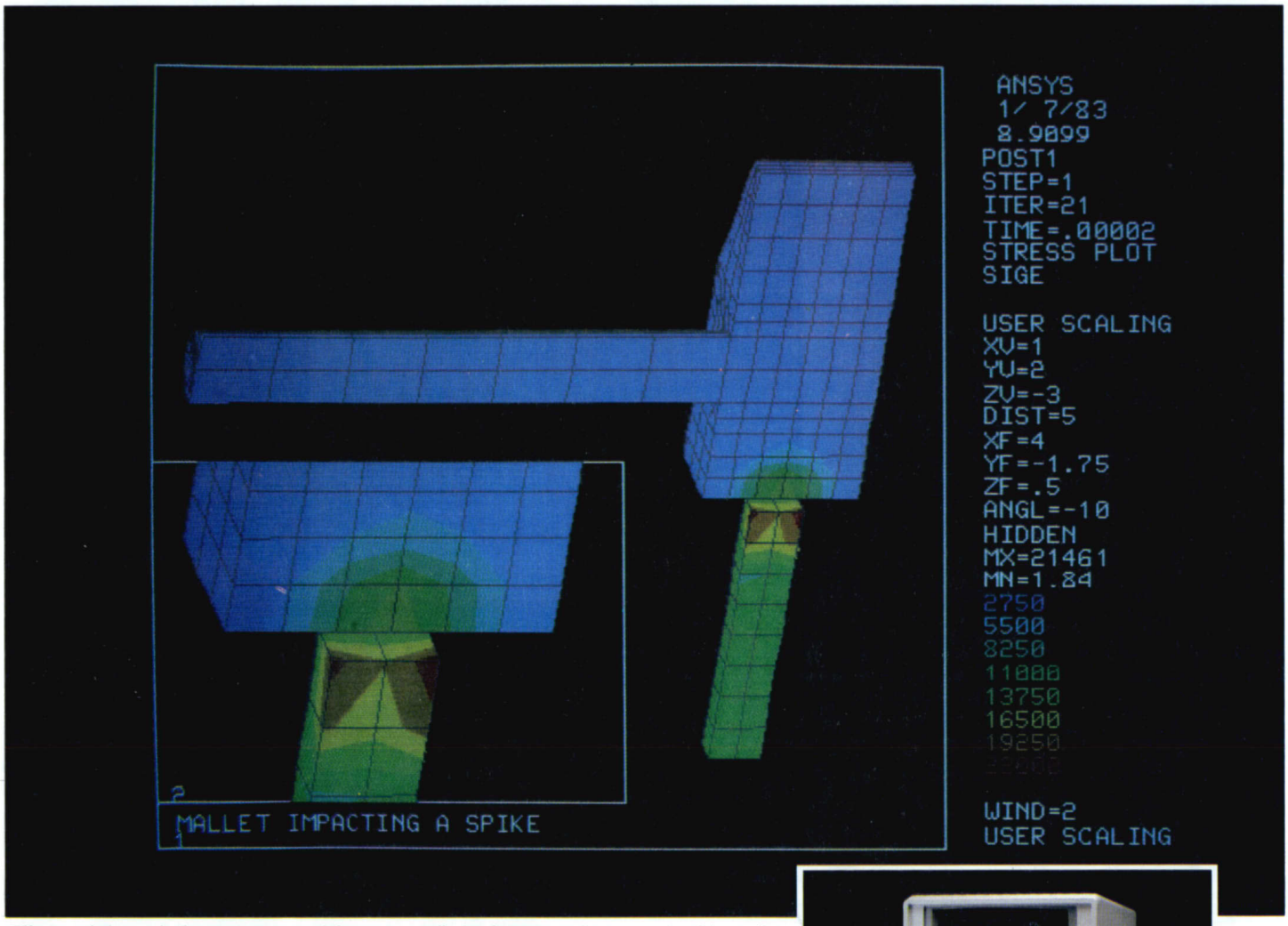
Up to 8 Graphic Planes and 256 Colors



The 4115B's user-selectable coordinate space is a staggering four billion x four billion points: enough to describe IC's in 0.001 μm increments. You can work with as many as eight graphics planes to provide 256 colors. 50,000 vectors/second redraw speed.

The 4110 Series can be configured either as a pedestal unit with detached low profile keyboard or in separate display, processing, and keyboard modules for flexibility in configuring workstations. Shown are the 4115B and M4115B. Foreground display courtesy of Swanson Analysis Systems, Inc. *See page 104.*

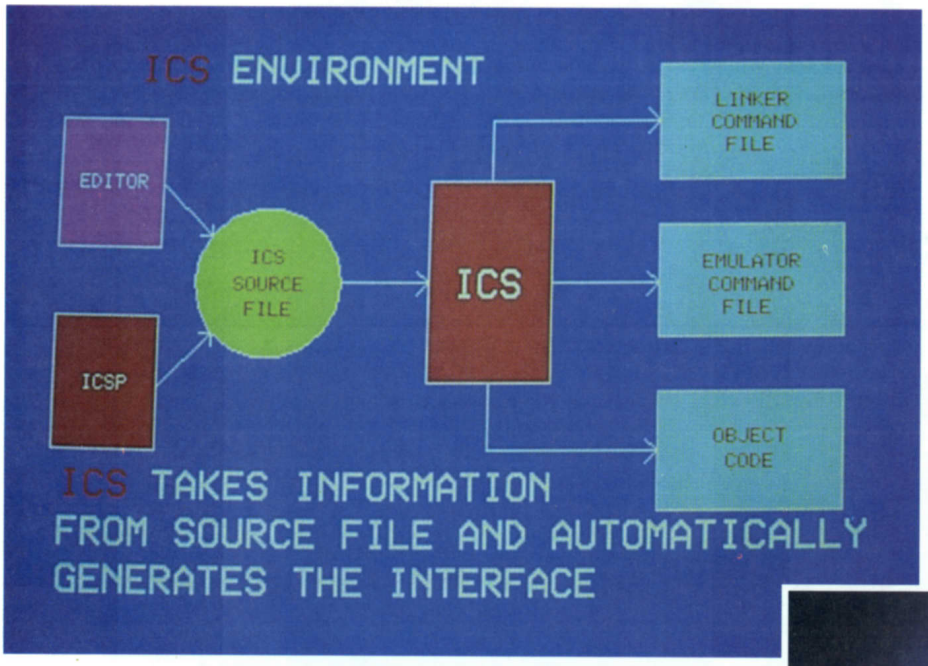
Graphic Segments, Plus Patterns and Surfaces, Enhance Data Discrimination and Manipulation.



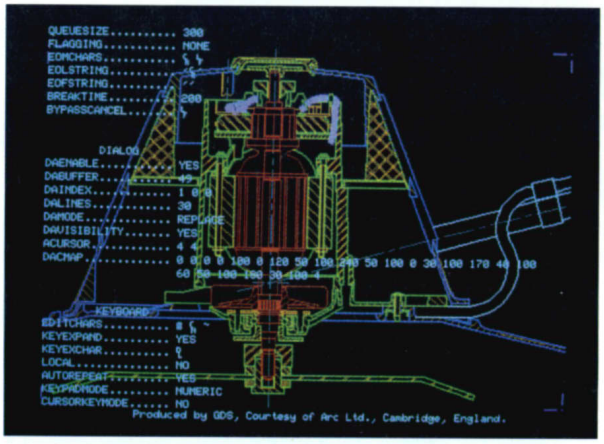
Effects of dynamic forces on materials scan easily be interpreted as seen in this mallet example. Displays courtesy of Swanson Analysis Systems, Inc.

Finite element models of large structures such as a section of concrete dam can easily be created, using the 4113B Computer Display Terminal. See page 107.

Low-Cost, High Quality Color Graphics and Alphanumerics



Color graphics is used in Tek's Microprocessor Development Products to help conceptualize complex software development tools. See page 45.

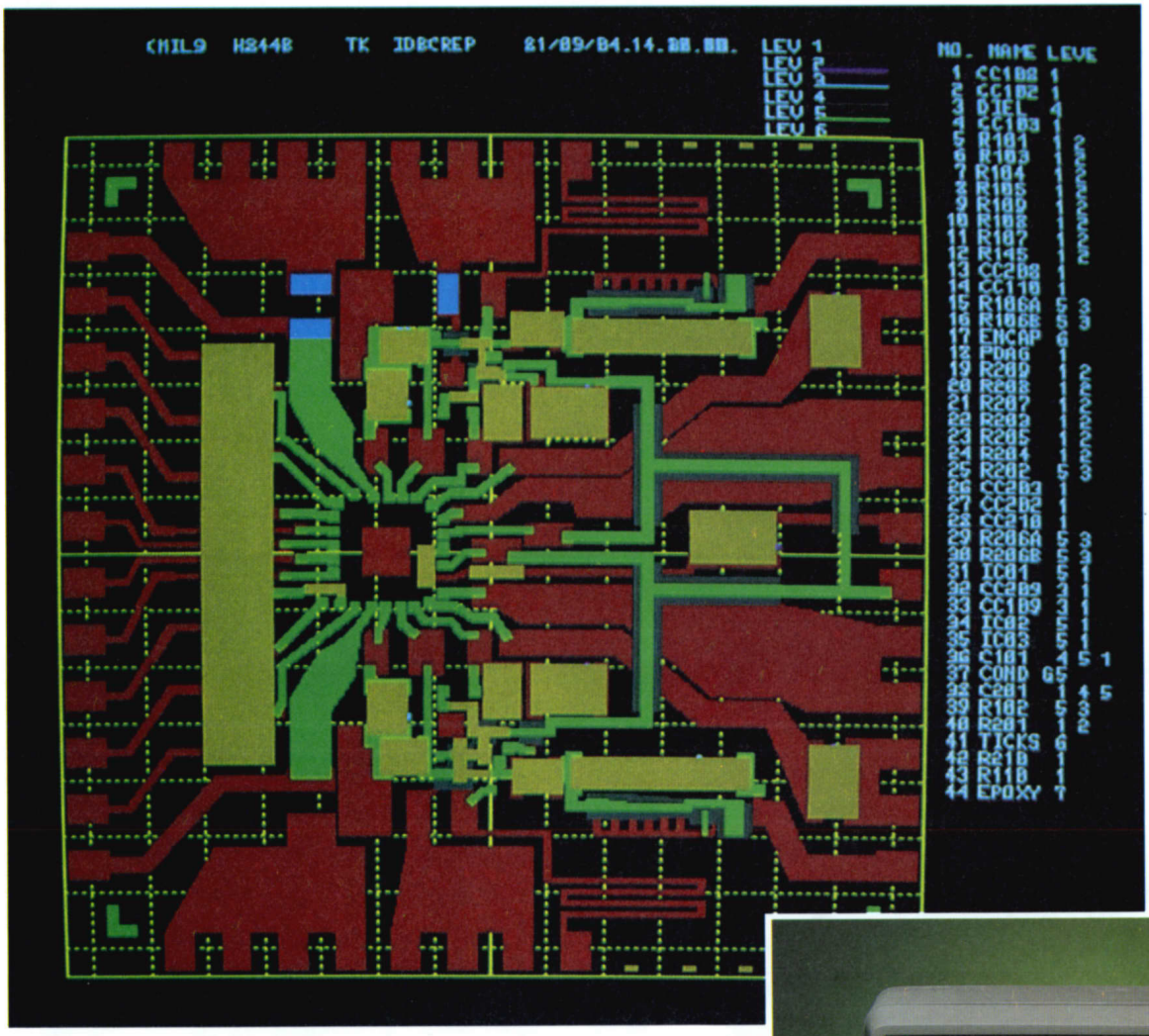


It is in the combination of alphanumerics and graphics that the desktop family excels. The terminals actually have two independent yet synchronized displays that allow them to perform as both alphanumeric and graphic terminals. The alphanumeric and graphic displays can be turned off and on and copied independently at the touch of a button. Two terminal functionality has been built into each of the Tek desktop family. The special transparent mode allows a full screen of alphanumerics and a full screen of graphics to be displayed simultaneously.

Display courtesy of Applied Research of Cambridge Ltd.

The 4105 is designed to produce complex graphics and pictures and perform the text editing tasks required by professionals in day-to-day data analysis and representation. As a result, it can also easily handle the simple bar graphs and pie charts and block diagrams normally required by business and management. Display courtesy of Integrated Software Systems Corporation.
See page 98.

Up to 256 k of RAM for Local Graphics Manipulation

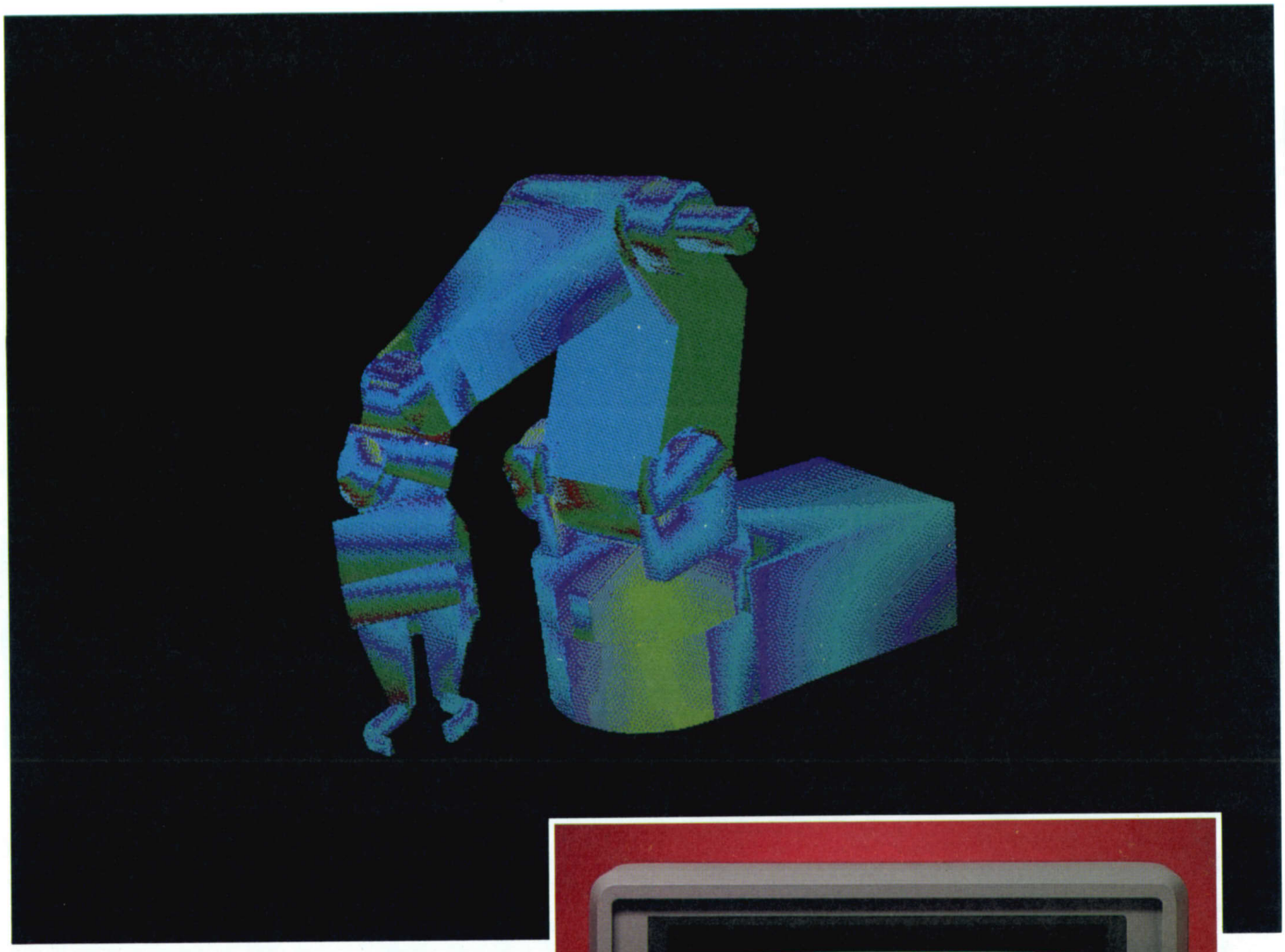


Color easily differentiates the various levels of this integrated circuit design.

The 4107 offers 640 x 480 pixel resolution . . . more than sufficient for highly technical drawings. See page 99.

Display courtesy of Applied Research of Cambridge Ltd.

Select From a Palette of 4096 Colors



Color shaded solid models, such as this robot arm, can be easily displayed on the 4109's display screen. Shaded solid models not only facilitate the communication of proposed product designs to management but also enable the engineer to visually analyze and interpret design alternatives. Display generated using SDRC GEOMOD courtesy of GE CAE International Inc. *See page 100.*

Produced by SAS Graph Courtesy of SAS Institute Inc.

Color Hardcopy With A Palette of up to 125 Shades

The 4695's bright, saturated colors and overall image quality are unsurpassed in its price range. The copier can place 120 dots per inch in both horizontal and vertical directions. *See page 102.*

COLOR HARDCOPY TECHNOLOGY

Information Sharing

Information sharing is a key factor in any application and most easily accomplished with some type of visual image such as graphic illustrations, photographs, etc.

The results could be presented in other forms (pages of numeric lists, for instance), but graphics are the preferred form for one simple reason: Graphics are visual, and colored graphics make most visual information easier to understand.

This need to share information, coupled with the growth of the use of color to clarify and define information, has resulted in expanded applications for color graphics copiers and plotters.

Pen Plotters

Pen plotters are another common technology for producing color copies, offering the advantages of high copy quality, low cost, low maintenance, and reasonably simple operation. They draw vectors and text directly from computer output. Since plotters are fairly slow, this output is sometimes "buffered" or "spooled" through a magnetic medium such as tape or disk to reduce the time burden on the host.

Plotter output is generally of very high quality, with clear colors and sharp lines. Because they can use several types of pens, a variety of line thicknesses are available. Line aberrations, such as stair-stepping, are minimal in pen plotters. In fact, except for the ability to easily fill areas, the pen plotter comes closest to meeting the quality expectations expressed by color graphics users. They can produce many of the kinds of graphics required by users, from plots for reports and archiving to camera-ready drawings and filmwork for CAD users.

Color Graphics Copiers

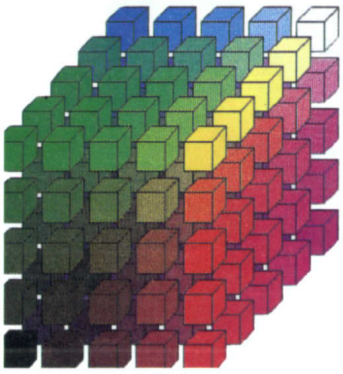
Tektronix Color Graphics Copiers use on demand ink-jet technology to produce eight-color copies from computer graphics displays. Ink-jet printers create graphics with fine dots of colored ink. The ink is simply accelerated toward the medium in fine droplets. Ink-on-demand generates tiny individual ink droplets for a particular graphics point when required.

The ink-on-demand technology has several advantages over a continuous ink circulation technology. A continuous ink circulation system requires frequent cleanup, and air bubbles and other contaminants introduced during recirculation can clog nozzles and even alter the chemical make-up of the ink. This can result in reduced color quality and persistence.

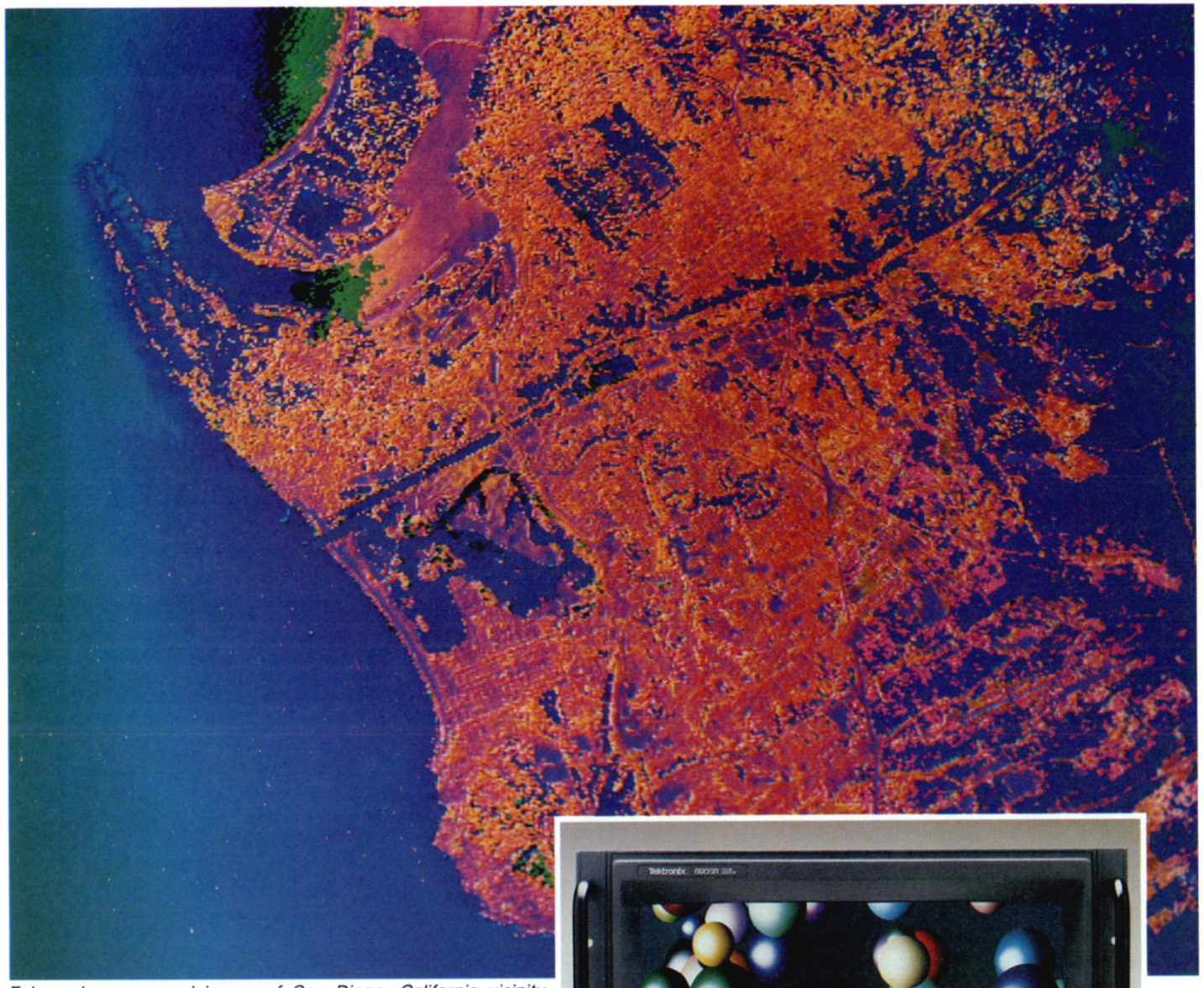
Ink-on-demand is clean, low maintenance and offers finer resolution than impact methods with better saturated colors and finer detail. It offers better area-fill capabilities than pen plotters and produces faster copies as well. This is particularly true when images are complex combinations of lines and filled areas, with text as well as graphics as part of the copy.

High Image Quality
150 Dots/Inch Provide Excellent Color Saturation

Both the 4695 and 4691 Color Graphics Copiers offer transparency and plain paper copies. Shown above are 4691 transparency and hardcopy samples. The color boxes show some of the variations available on the 4691. *See page 103.*



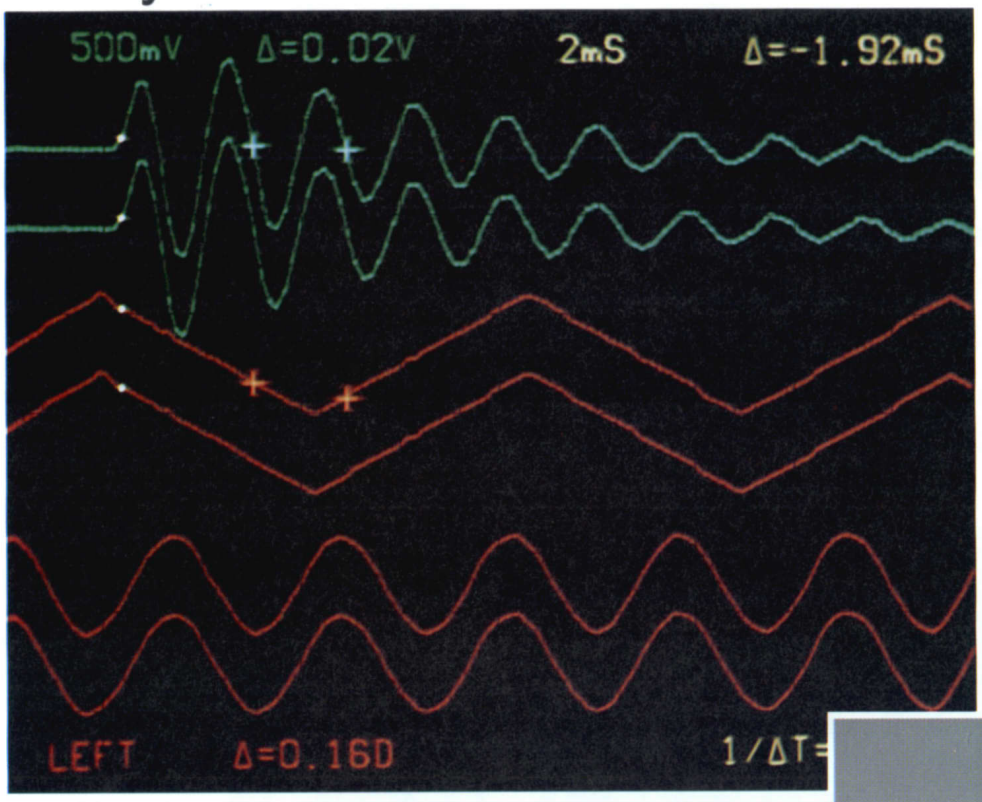
Color Monitor's Versatility Provides High Performance in a Wide Variety of Applications



False-color-processed image of San Diego, California vicinity benefits from precision characteristics of the 690SR Color Display.

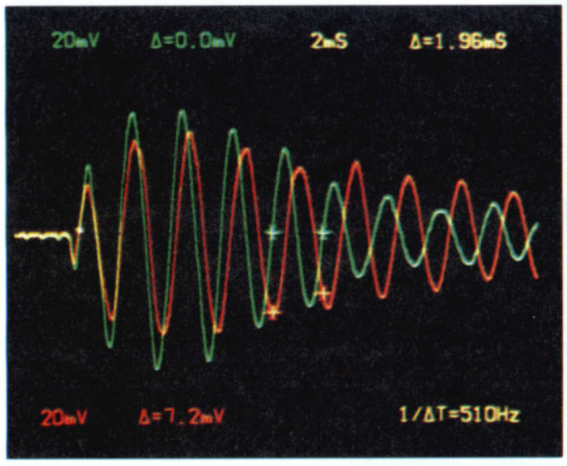
The photograph of a 690SR screen shows the image created by an experimental system which uses dither to decrease edge effects and contouring allowing minimization of the size of the image memory. *See page 185.*

Low-Cost, High-Resolution, Easily Discernible Multichannel Displays

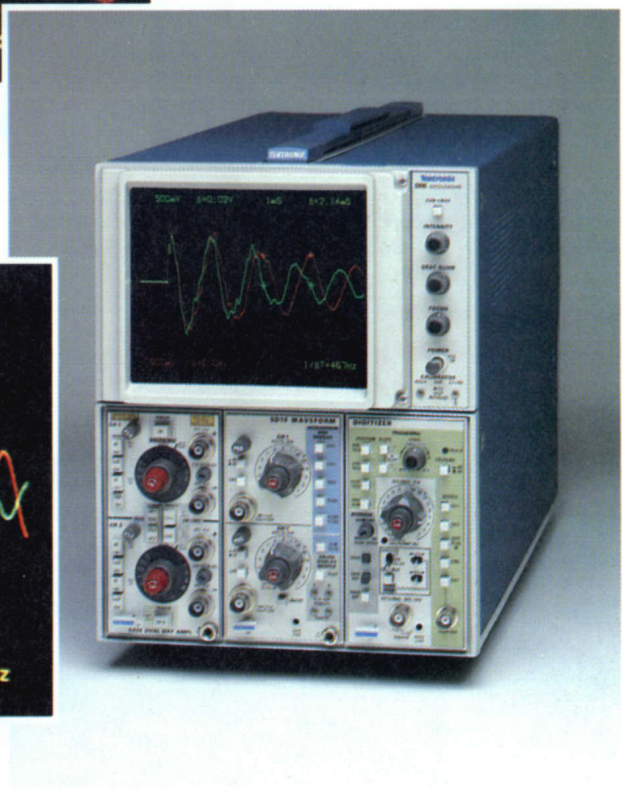


ACTUAL SIZE

This multichannel application uses a 5000-Series amplifier in the left compartment of the 5116 Oscilloscope to precondition the signal. Here a stored reference trace is compared with a later signal acquisition.



The color oscilloscope allows full-screen multichannel displays, as in this transducer measurement showing vertical displacement and velocity after a shock test.



The 5116 Color Oscilloscope with 5D10 Waveform Digitizer, and the 5A26 Dual Differential Amplifier. See page 292.

Improved Accuracy and Speed In Logic Analysis

ACTUAL SIZE

Color assists the user in understanding disassembled state data from microprocessors: yellow for instructions, green for memory reads and writes, and yellow-on-red for user-programmable highlights.

The large, easy-to-read color display of microprocessor mnemonics saves time for engineers debugging system operation.

Red cursors allow the DAS 9100 user to easily identify short time intervals, down to 1.5 ns! See page 65.

Tektronix Means . . . Measurement Capability, GPIB Compatibility

As measurement needs grew in number and complexity over the past few decades, people began to realize that traditional design and test procedures were becoming inadequate. When the inadequacies became intolerable, special interfaces were designed and various instruments were connected to controllers to form specialized test systems. From these beginnings, some major benefits of automated test and measurement were quickly realized:

- Test and measurement labor costs were reduced.
- Human error decreased through precise and repeatable automation of measurements.
- Skilled people were released from mundane or repetitive procedures to pursue more creative research and design activities.
- Sophisticated analysis techniques could routinely be applied to provide greater insight into devices and processes.

But, for all their benefits, automated test and measurement systems still had some significant problems. Mostly, these stemmed from each system being unique, custom built. The automation need had to be severe to justify custom design costs. Systems and data formats were not generally compatible with each other. And changing the system or adding instruments meant another custom design effort.

Test and measurement automation was still too fragmented and costly for general use, even though the benefits were generally needed. A standard interfacing system providing across-the-board compatibility for a variety of instrumentation and instrument controllers seemed to be the solution.

The First Step Toward Compatibility

In 1975, the first major step toward general compatibility in electronic instrumentation for systems use was taken. This step was publication of the IEEE Standard 488-1975 defining an interface and communications bus for programmable instruments. This bus is commonly called the GPIB—the General Purpose Interface Bus.

In 1978 the standard was further refined (IEEE Standard 488-1978) defining an interfacing system that has become a widely accepted instrument industry standard. The major areas it specifies are:

1. Mechanical—the interface connector and cable. See Table 1.
2. Electrical—the logic signal levels and how the signals are sent and received.
3. Functional—the tasks an instrument's interface may perform—such as sending data, receiving data, triggering the instrument, etc.—and the protocols to be used. See Table 2.

Today, a wide variety of instruments include interfaces conforming to this mechanical, electrical, and functional standard. These GPIB-compatible instruments and instrument controllers make it possible to achieve the benefits of automated test systems without paying the previous price of custom system design. With GPIB compatibility, measurement capability can be chosen off-the-shelf and simply cabled with standard bus cables in either a linear or star configuration.

TABLE 1
GPIB HARDWARE CHARACTERISTICS SUMMARY

- Cable lengths up to and not exceeding 20 meters (approximately 66 feet) with a device load required for every 2 meters of cable.
- Up to 15 devices (1 controller and 14 instruments) may be connected in linear or star configurations.
- Voltages are generally TTL-compatible.
- GPIB signal and data lines are asserted (or true) when pulled low ($\leq +0.8$ V) and released (or false) when pulled high ($\geq +2.0$ V).
- Maximum data rate of up to 250 kilobytes/second over a distance of 20 meters with 2 meters per device or faster with some special restrictions (refer to IEEE Standard 488-1978 for details).

TABLE 2
INTERFACE FUNCTIONS DEFINED BY IEEE STANDARD 488-1978

Function	Description
Source Handshake (SH)	Synchronizes message transmission
Acceptor Handshake (AH)	Synchronizes message reception
Talker (T)	Allows instrument to send data
Listener (L)	Allows instrument to receive data
Service Request (SR)	Requests service from controller
Remote-Local (RL)	Allows instrument to select between GPIB interface and front-panel programming
Parallel Poll (PP)	Allows up to eight instruments to simultaneously return a status bit to the controller
Device Clear (DC)	Puts instrument in initial state
Device Trigger (DT)	Starts some basic operation of the instrument
Controller (C)	Sends device addresses and other interface messages

Tektronix' Systems Experience

Long before publication of the IEEE Standard 488-1978, Tektronix had entered the test and measurement systems business. The measurement speed and capabilities of the Tektronix automated oscilloscope and Tektronix semiconductor test systems quickly highlighted the benefits to be gained from measurement automation. And just as quickly came the realization that a system interfacing standard was needed. But what standard?

The possibilities of the proposed IEEE Standard 488 were recognized. And, when the IEEE Standard 488 became reality, GPIB compatibility was already an integral part of Tektronix product planning and engineering. The result is that Tektronix is now a recognized major supplier of a full line of GPIB system components—a supplier that puts more than a decade of systems planning, design, and implementation experience into each product.

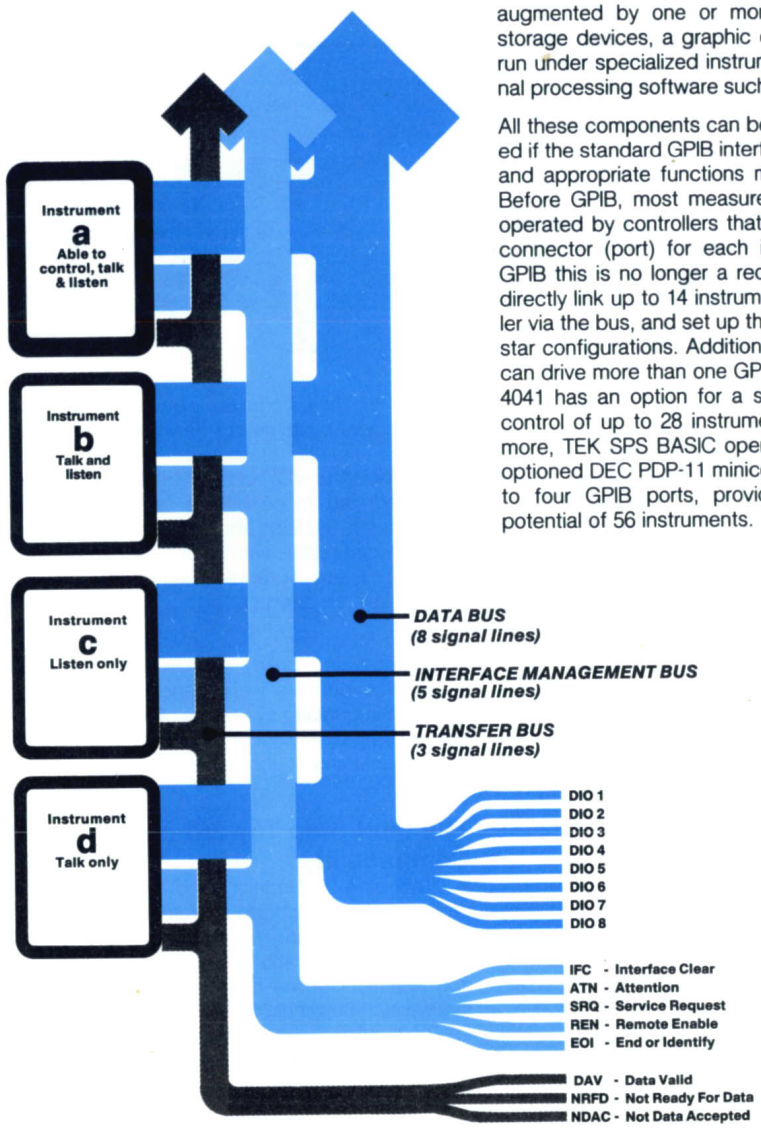
GPIB System Components

An automated test and measurement system usually consists of the following components:

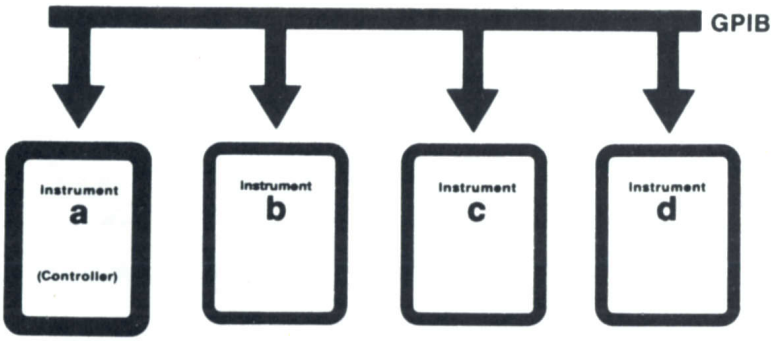
- Multiple instruments: these are either *stimulus* instruments, such as function generators, pulse generators, and power supplies, or *measurement* instruments, such as counters, waveform digitizers, and multimeters.
- Controller with software: this tells the instruments what to do, collects the results, and processes them. The system controller is generally a small computer. The software or firmware operating system must have a powerful, flexible I/O structure to handle GPIB bus traffic. It must also have processing power for waveform manipulation and graphics power for display.
- Computer peripherals: these are devices such as tape drives, printers, and plotters that store or display the results of the tests.
- A keyboard: this enables the user to send commands or information to the system.
- A display: the display allows the user to review intermediate results and to monitor system operation.

For smaller systems, these last three components are often incorporated in the system controller—a desktop computer, such as the Tektronix 4050 Series, that is specifically designed for use with instrument systems. Larger, more powerful systems, however, may be minicomputer-based, augmented by one or more high-speed mass storage devices, a graphic display terminal, and run under specialized instrument control and signal processing software such as TEK SPS BASIC.

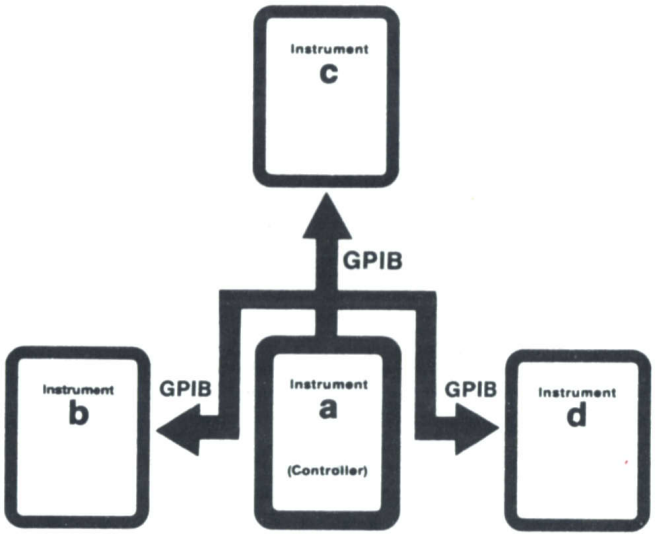
All these components can be easily interconnected if the standard GPIB interface has been built in and appropriate functions made programmable. Before GPIB, most measurement systems were operated by controllers that required a separate connector (port) for each instrument. With the GPIB this is no longer a requirement. Users can directly link up to 14 instruments with the controller via the bus, and set up the systems in linear or star configurations. Additionally, some controllers can drive more than one GPIB port. The Tektronix 4041 has an option for a second port, allowing control of up to 28 instruments. Or, if you need more, TEK SPS BASIC operated with a properly optioned DEC PDP-11 minicomputer can drive up to four GPIB ports, providing a total system potential of 56 instruments.



Linear Configuration



Star Configuration



All these devices (the controller, measurement instruments, and peripherals) comprise the hardware. The system cannot operate, however, unless it is driven by software.

There are two levels of software necessary, the operating system software and the user written application programs. The operating system software provides a set of commands and functions that the user combines into a program that delineates the measurement and processing task to be performed. The software, guided by the user program, works through the controller to tell the instruments what signals to generate, what measurements to make, and tells the controller what to do with the results.

The software and the program in the controller make the system do what the user wants. The GPIB interface allows users to plug system components together, but without software, the system can do nothing.

In programmable instrument systems, the "language" of the software or program has several meanings:

1. The controller has its own language, such as BASIC, and users must express their intentions in this language.
2. Within the context of the controller's language, the instrument's commands (or "language") have to be sent over the GPIB.
3. The actual control of the GPIB interface is transparent to the user with Tektronix instrument controllers and software.

In order to make the system operate, the user has to:

1. Know what tasks the system is to perform—the system can do nothing by itself.
2. Know the controller's language.
3. Know the kind of data or language the instruments are designed to exchange.

To make these tasks easier for you, Tektronix has taken several steps beyond simple IEEE Standard 488-1978 compatibility. Consistency has been designed into each system component for the greatest degree of compatibility. Intelligence has been designed in to relieve you from interfacing details. And firmware and software have been designed and written to provide the maximum in programming ease and measurement capability.

Consistency Makes a Big Difference

Tektronix GPIB products are designed and thoroughly evaluated for compliance with IEEE Standard 488-1978 and for compatibility with one another. Because these products are designed to be compatible (i.e., meet the same standards), users usually won't need to make hardware and software modifications for each new addition or deletion to the configuration. Many software routines need to be written only once, after which only minor modifications are needed with the addition of new instruments.

A status check routine, for instance, will work on all Tektronix GPIB instruments. A message terminator common to all Tektronix GPIB instruments is a further benefit. But, since the IEEE Standard 488-1978 allows several optional message terminators, Tektronix instruments go an extra step by providing a switch for selecting optional terminators. These features provide users with the capability of quickly configuring and reconfiguring interactive and automated measurement systems.

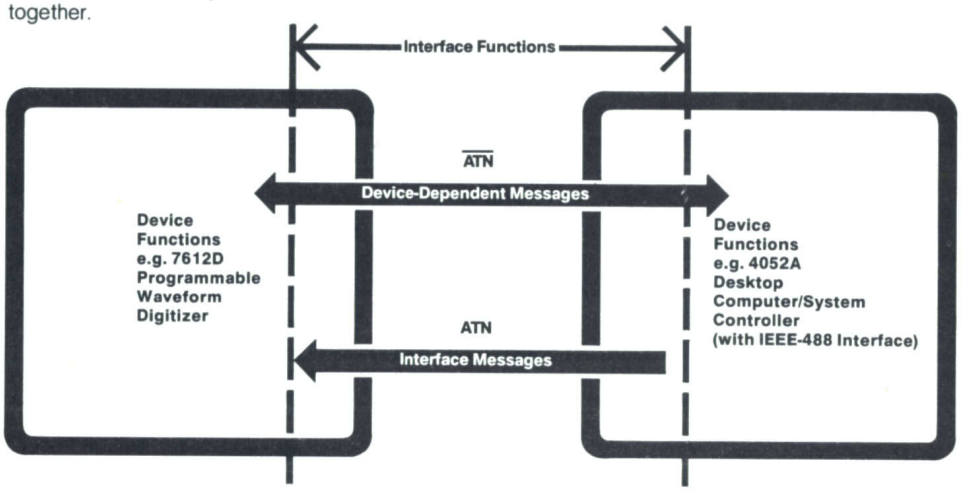
The result is a line of products that are not only GPIB compatible—but are capable GPIB instruments with the features that make them useful and the compatibility that makes them work together.

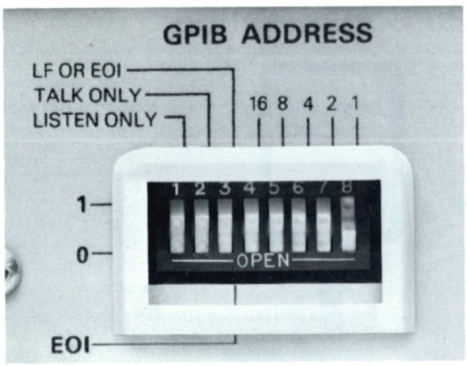
Tektronix Standard Codes and Formats Means Programming Ease

The IEEE Standard 488-1978 specifies the hardware interface and its basic functional protocol. It also specifies a set of codes called interface messages that control interface functions. However, the IEEE Standard 488-1978 does not specify the syntax or coding of device-dependent messages—the messages that control the programmable features of the instrument.

Since the device-dependent messages are not specified, instruments that conform to the IEEE Standard 488-1978 may use inconvenient or even incompatible message formats. It's much like a telephone system—the hardware link is well defined, but unless both parties speak the same language, communication is impossible. That's why Tektronix developed a codes and formats standard that specifies the syntax and coding of device dependent messages, while retaining full IEEE Standard 488-1978 compatibility. The Tektronix *Standard Codes and Formats* specifies message coding to:

- Be simple and unambiguous
- Use commands that are common among similar devices
- Use simple, easy-to-remember mnemonics.





Each GPIB instrument or peripheral, called a device, must be assigned a different system address; this can be done simply by setting switches, usually located on the back panel of the device.

The benefits of the Tektronix ***Standard Codes and Formats***, a major feature of the Tektronix GPIB communications protocol, are numerous. Because of their natural English-like structure, instrument control commands and messages are easy to use. The result is a GPIB implementation that is specifically designed to overcome the programming rigidity and cumbersome procedures of other GPIB systems.

ASCII Data Standard
Since most controllers accept ASCII data directly, Tektronix GPIB instrument commands are coded in ASCII. This eliminates the need for error-prone data conversions or byte-by-byte encoding. For example, to set the center frequency of the 492P Spectrum Analyzer to 1.75 MHz, the command is simply written FREQ 1.75 MHz—no more calculated percentages of full-scale or BCD equivalents. Settings for Tektronix GPIB instruments are sent as ASCII data in human readable form.

Flexible Formats
Many minor format items that are aggravations in other systems are also taken care of by Tektronix ***Standard Codes and Formats***. For example, Tektronix GPIB instruments accept negative zeros and leading and trailing spaces; they also overlook inconsistent use of upper and lower case letters. And, since truncated numbers can drastically affect measurements, Tektronix GPIB instruments round off rather than truncate: e.g., a value of 2.49 becomes 2.5 rather than 2.4. In short, the built-in intelligence is used to make intelligent decisions. That makes your programming job much less rigid and substantially easier.

Common Messages
To make things even easier, Tektronix ***Standard Codes and Formats*** also specifies messages that are to be common to all Tektronix programmable instruments. For example, you can program your system to learn the current settings of any Tektronix GPIB instrument by sending the instrument the SET? message. Any GPIB compatible instrument from Tektronix—whether it is a waveform digitizer, a programmable power supply, or a function generator—interprets SET? the same way. The instrument firmware gathers the instrument's settings together and assembles them into a human readable message to be sent over the bus to the controlling software. If you know how to operate a function generator, then you already know how to read a settings message from a Tektronix GPIB compatible function generator.

Tektronix 4041 System Controller

BASIC Languages
Because users are increasingly interacting with GPIB systems at the controller keyboard rather than at instrument panels, GPIB systems must be as friendly as possible. This means, too, that the controller languages should be simple, logical, and easy to interpret and implement. That's why BASIC, the established language for Tektronix instrument controllers, is the preferred language of Tektronix ***Standard Codes and Formats***.

BASIC is an established language with wide use and familiarity. It is also an English-like language that is easy to learn and understand. So, combined with the English-like messages used with Tektronix GPIB instruments, it becomes a consistent and familiar means of communicating with your system. And your program listings are easy to read and follow, with very little interpretation required. (For more details on Tektronix ***Standard Codes and Formats***, ask your Tektronix Sales Engineer or Representative.)

Controllers to Match Your Needs

Tektronix offers three controller-software packages to meet varying GPIB system needs. These packages are:

- The 4041 System Controller, optimized for instrument control in a variety of situations.
- The 4050 Graphic Computing Systems, optimized for desk-top instrument control and computing with full graphics capabilities.
- TEK SPS BASIC software with the DEC PDP-11 Series minicomputer, optimized for systems with full waveform acquisition, processing, and graphics.

The 4041 System Controller
The 4041 System Controller is a compact, modular controller designed for rackmount, bench-top, or portable use. Its operating system language is an extended BASIC designed for use by both the casual and the sophisticated programmer.

The 4041 controller contains three microprocessors, with the CPU being the powerful 16-bit 68000. Standard memory is 32 kilobytes with optional expansion to a maximum of 160 kilobytes. A 20-character alphanumeric LED display, a 20-character thermal printer, a DC 100 cartridge drive, 18 function keys, a GPIB port, an RS-232 port, and a real-time clock and calendar capability are all standard. An additional GPIB/ RS-232 port pair is optional, with the second GPIB port having Direct Memory Access capability. With 14 GPIB instruments per GPIB port, the 4041 System Controller offers the capability of controlling up to 28 GPIB instruments. Also optional are an 8-bit parallel TTL port, and a detachable program development/debug keyboard.

The capabilities of standard 4041 BASIC can be expanded by installing ROM (Read-Only Memory) packs to extend operational features of the 4041 into a broad range of systems applications, with functions running faster than equivalent BASIC routines.

The program development ROMs (with keyboard, or an RS-232 terminal), give the engineer or production test programmer access to the system language. Its English-like commands, simple syntax, and line-by-line interpreter implementation combine for a friendly and interactive system. A variety of other features are also included to increase friendliness. For example, variable names may be up to eight characters long, allowing meaningful names such as RISETIME, VOLTAGE1, or DELAY. And, as another example, subprograms and program lines can be named—e.g., 1000 SRQPOLL: or 200 RMS VOLTS:—for quick and easy access.

The 4041R01 Graphics ROM pack gives the 4041 the capability to generate graphic commands to interact with peripheral devices using Tektronix compatible graphic codes. These high-level and primitive commands allow you to construct and incorporate graphic images, symbols, charts and diagrams into your system applications. System usability is greatly enhanced when supported with a graphic human interface.

The 4041R02 Plotting ROM Pack gives the 4041 the capability to generate graphs and to plot data. Designed as an easy-to-use tool to automatically generate scientific graphics, the plotting ROM pack requires the presence of the 4041R01 Graphics ROM Pack in order to operate. Graphs can be generated and displayed on any graphic peripheral device supported by the 4041R01. The automatic plotting commands are the heart of the 4041R02. These commands, given your data, draw axes with appropriate tic marks and plot the desired data. You need little experience to program graphics or plotting routines. All you need to do is supply the data to be graphed.

The 4041R03 Signal Processing ROM Pack gives the 4041 the ability to support instrumentation system applications requiring waveform processing. Coupled with our programmable digitizers and oscilloscopes, it will produce broader system configurations and effective solutions for signal analysis. The functions contained in the 4041R03 provide a high level approach to deal with signal processing applications normally solved by lengthy programs requiring extensive knowledge of waveform processing and computer fundamentals. Combined with the graphics and plotting ROM packs, the 4041R03 allows you to produce, analyze and display waveforms semiautomatically.

The 4041R04 Utility ROM Pack adds still more general purpose capabilities to your 4041. These range from such convenience items as one line descriptions of error codes to capabilities for building PROM files for programming your own EPROMS.

Beyond enhancements for simplicity, 4041 BASIC also has enhancements that make it a powerful tool for sophisticated programmers, too. It includes capabilities for FORTRAN-like subprograms, variable passing from main program to subprograms, declaration of local and global variables, and many other features.

Yet, for all its sophistication, the 4041 is still particularly desirable for use by lower-skill operators in a production environment. Instrument control programs can be designed and written to print user prompts on the 4041 display and the programs can be assigned to any of the ten user-definable keys on the 4041 front panel. Then the 4041 program development ROM and keyboard can be removed from the controller. This puts the 4041 into an execute only mode with its programs protected. The lower-skill user need only follow the front-panel display prompts and press the designated keys to execute programs.

To return to the engineering or program development mode, simply plug the program development ROMs (with keyboard or an RS-232 terminal) back into the 4041. You again have access to all of the ease and power of 4041 BASIC programming.

Tektronix 4052A Desktop Computer

The Tektronix 4050-Series Desktop Computing Systems

The 4050-Series systems are especially convenient for engineering bench or laboratory support of GPIB compatible instruments. The typewriter style keyboard, built-in calculator keypad, and special programmable keys provide easy operation. In addition, the GPIB interface port provides for control of up to 14 GPIB instruments at a time.

Tektronix 4050 Series systems have an exclusive high-resolution storage display for unexcelled graphic clarity and detail. There is no distracting screen flicker. All lines are continuous, never detracting from or distorting information.

This built-in graphics capability allows interactive graphic manipulation to help visually analyze waveform data before it is processed. A user can often gain valuable insights or decide to investigate a new direction once the acquired data is graphically displayed.

Supporting the advanced, interactive graphics capability is powerful computer performance. Features such as full array processing, an invaluable tool for handling whole waveforms, and dynamic memory allocation, reduce the worry about data movement in the system.

Additionally, a range of peripheral products are available with Tektronix 4050 Series Desktop Computing Systems to provide analysis records in many sizes and formats. Tektronix peripheral products include hard copy units, digital plotters, graphic input tablets, and disc memory systems.

With 4050 Series Systems, you can immediately start using a high-level extended BASIC. This universal technical language is well adapted to technical needs of the user and includes extensions for increased computational power and further ease of use.

Tektronix also supplies general utility software programs for various communication routines, such as bi-directional transferring of waveform data, test results, and instrument settings. And acquired data can be quickly graphed on the display screen. Graphic waveform handling is enhanced by built-in features such as auto-scaling, where unknown quantities of waveform data can be scaled into a defined set of graphic coordinates by a few key-stroke operations. Coordinates may be defined for Log-Lin, Log-Log, or even Smith Chart and Bode plots—whichever is relevant to your application. Any of the displays can be quickly copied to paper.

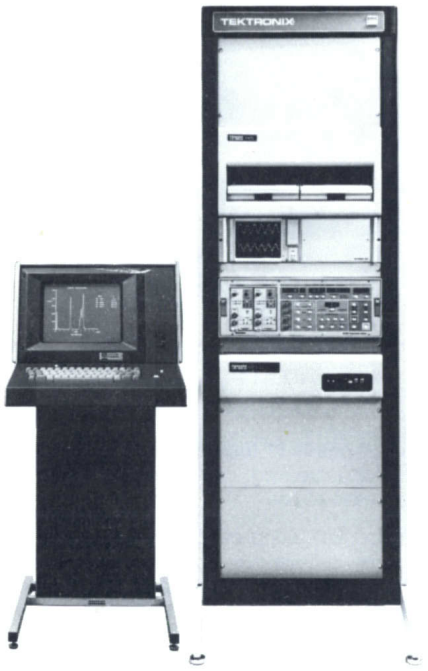
Some of the more common signal processing tasks can be accomplished using firmware supplied by Tektronix. Plug-in ROM packs for the 4050 Series controllers provide specialized waveform processing commands. For example, the Signal Processing ROM Packs use versatile English-like commands to handle data arrays or whole waveforms.

Other ROM pack capabilities include fast Fourier and inverse Fourier operations. The fast Fourier transform can transfer whole waveforms from the time domain to the frequency domain in a matter of seconds.

Still other ROM packs offer a real-time clock, advanced graphic handling features, data conversion packages, and other GPIB computational tools.

TEK SPS BASIC Software with DEC PDP-11 Minicomputers

When equipped with Tektronix supplied GPIB interfaces, DEC PDP-11 Series minicomputers can be operated with TEK SPS BASIC software to provide the most powerful of big-system instrument control and signal processing. A wide variety of peripherals can be handled, including plotters, line printers, graphic terminals, magnetic tapes, and single or multiple disk storage systems. Additionally, with the proper options, up to four GPIB interface ports can be supported. This means control of and data collection from up to 56 GPIB instruments.



Tektronix WP3202 Signal Processing System using TEK SPS BASIC and a DEC PDP-11 Minicomputer

Two versions of TEK SPS BASIC are available, the standard version and the extended memory version. The extended memory version permits processing of very large arrays in computers having up to 128 kilowords of memory with memory management.

Other than memory differences, both versions of TEK SPS BASIC software have the same major features. These include a modular architecture consisting of a resident monitor and an expandable library of over 100 nonresident commands. This unique design lets you configure a software system to meet your specific needs yet leaves the system open for adding new commands and processing modules.

Measurement data can be stored and accessed in a variety of ways. Information can be read or written in either ASCII or binary. Named files can be accessed on hard or flexible disks, magnetic tape, or cassettes. Information can be read from files either sequentially or randomly. TEK SPS BASIC commands give you complete file management capability.

Comprehensive graphics permit waveform plots and X-Y plots between waveforms. Either can be done with single commands. The output is complete with scaled and labeled axes and can be hard-copied to paper.

There's also data logging capabilities for automated waveform capture. And the software's better than 7-digit precision means much higher resolution than possible in conventional oscilloscope measurements. Plus, there are special data structures to retain both numeric and literal information (scale factors and units) associated with a given waveform. This waveform data structure, as well as numeric arrays or portions of numeric arrays, can be operated on arithmetically as easily as can simple numeric variables.

Beyond extending the standard mathematical operations and functions to include waveform processing, TEK SPS BASIC also provides special waveform processing functions. Waveforms can be integrated, differentiated, convolved, correlated, and fast Fourier transformed—all with single commands. Polar conversions can also be performed with a single command to present results as magnitude and phase.

With its large array size capabilities (limited only by memory in most cases), advanced signal processing, and program and instrument tasking capabilities (including error control for independent operation), TEK SPS BASIC offers all of the flexibility and power necessary to control anything from the simplest to the most sophisticated test and measurement system.

Guide for Selecting GPIB Instruments

When selecting GPIB instruments for a specific application, be sure to check several key specifications for suitablity in the configuration.

First, make sure that the instrument can make the desired measurements. Next, determine that the interface functions are compatible with the proposed usage and with other instruments in the GPIB configuration. The following items should be used as a checklist with your sales representative when considering instruments to be used in GPIB configurations:

1. Is the instrument intended for interactive measurement analysis or automated measurement; i.e., are all necessary instrument functions remotely programmable, or will an operator be available to adjust settings?
2. Does the instrument's GPIB interface have the necessary set of functions implemented at the desired level? (For example, AH1 is needed for any useful interaction, SH1 is required for instruments supplying measurements to the controller.)
3. Are diagnostics available to check out the instrument from the front panel or over the GPIB interface?
4. Does the instrument use standard codes and formats conventions for terminators, numeric formats, etc.?
5. Can the instrument's front-panel setting be read from the controller and saved for later automated set up?
6. Can the front panel be "locked out" via the GPIB?

Tektronix Support for Your GPIB System

With GPIB products and signal processing systems from Tektronix, you're not left on your own after the product is purchased. Tektronix offers complete support and training for the operation and maintenance of its GPIB products and systems.

Every product is shipped with a complete and comprehensive operating manual. Additionally, a variety of training services are available. Training classes are available both at our Beaverton campus and in the field.

As part of the long-term support for GPIB products and systems, Tektronix offers a variety of application literature and support.

For users of 4050 Series controllers, there is *TEKniques*, the **IDD Applications Newsletter**. It covers the field of 4050 applications and provides abstracts of new software contributions to the IDD Program Exchange Library.

HANDSHAKE is another newsletter available from Tektronix. It's published quarterly and contains application and technical articles covering the broad spectrum of instrument control and signal processing.

The Tektronix Instrumentation Software Library provides programs for Tektronix programmable measurement instruments. The Tektronix Instrumentation Software Library catalog provides program abstracts and ordering information.

An extensive collection of application notes and magazine article reprints is another source of information offered by Tektronix. Our Field Offices and Sales Representatives maintain a list of current literature and will be glad to supply you with items in your areas of interest.

Warranties and service are another part of the support you get from Tektronix. Tektronix maintains a network of service centers for your maintenance needs.

WAVEFORM ACQUISITION PRODUCTS

NEW **336 Option 01**
Digital Storage Oscilloscope

- 140 kHz Storage Bandwidth
- Time and Voltage Measurement Cursors
- 50 MHz Nonstorage Bandwidth
- CRT Readout, Only 5 kg (11 lbs)
- Signal Averaging

This compact oscilloscope can simultaneously display analog and digital waveforms, and can store up to 16 digitized waveforms for recall and display. Vertical and horizontal scale factors, delay time position, and voltage and time readouts of cursor positions are displayed on the CRT, as is a menu of many of the features and modes. An Auto mode for both vertical volts/div and horizontal time/div allows "hands-off" operation in many applications. See page 352.

468 Option 02
Digital Storage Oscilloscope

- 10 MHz Storage Bandwidth
- Time and Voltage Measurement Cursors
- 100 MHz Nonstorage Bandwidth
- Signal Averaging

This portable, high-performance oscilloscope uses a unique display interpolation system to store and display single-shot events. Envelope mode can be used to catch glitches, view frequency drift and amplitude modulation, or detect aliasing. Can be used with a 4924 Tape Drive to record waveform data on-site for subsequent filing or computer analysis. Option 02 GPIB interface for outputting waveforms as addressable talker. See page 350.

NEW **7D20/7D20T**
Programmable Digitizers*[1]

- 70 MHz Equivalent Time Bandwidth
- 40 MHz Sample Rate
- 8-Bit Vertical Resolution
- Pretrigger and Posttrigger
- Simultaneous Acquisition on 2 Channels

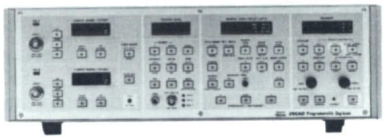
The 7D20 plug-in converts any 7000 Series mainframes into fully programmable, digital oscilloscopes. Operating modes include: Envelope, Average, and Roll. Optimized for interactive and automated applications, from biomedical research to radio modulation. Remotely controllable over the GPIB.

The 7D20T provides the same digitizer capabilities in a compact stand-alone package. See page 337.

7912AD Programmable Digitizer*[1]

- 100 GHz Equivalent Sampling Rate
- 500 ps/div Calibrated Sweep Rate
- 500 MHz Bandwidth at 10 mV/div
- Built-in Signal Averaging

This unique product can digitize and store single-shot or repetitive signals from millisecond to subnanosecond duration. Waveform data is stored in a 4096 word memory. Designed for interactive and automated applications, this waveform digitizer is very useful in laser research. The digitizing technology employed in this instrument provides an equivalent sampling rate up to 100 GHz. See page 346.



390AD Programmable
Waveform Digitizer*[1]

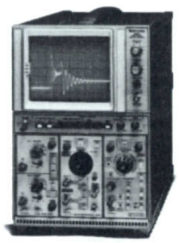
- Cursor-Based Measurements
- Sample-Rate Switching
- Direct Plotter Output Capability

This two-channel, 10-bit digitizer achieves excellent dynamic accuracy with a two-stage flash-conversion process. Single-channel operation can provide 60 megasamples per second. Built-in self-calibration and self-test features. Remotely controllable over the GPIB. Applications vary from ultrasonic testing to video. See page 342.

7612D Programmable Digitizer*[1]

- 200 MHz Dual Channel Sampling
- Dual Time Base
- Variable Record Lengths to 2048 Words Each Channel
- 8-Bit Vertical Resolution
- Pretrigger and Posttrigger
- Sample-Rate Switching

Two independent waveform digitizers in one compact instrument, the 7612D is ideal for use with Automatic Test Equipment or anywhere highly accurate, time-domain measurements are required. Digitizing accuracy is provided by a unique type A/D converter working with an ultra-high-speed comparator. Memory partitioning helps capture fast, successive, randomly occuring events. Multiple sample rate switching is available during waveform acquisition. Remotely controllable over GPIB. See page 344.



5223 Option 10
Digitizing Oscilloscope*[1]

- 1 MHz Equivalent Time Bandwidth
- 1 MHz Sample Rate
- 10-Bit Vertical Resolution
- Pretrigger and Bi-Slope
- X-Y Analog Plotter Output
- Roll and Vector Modes

This 10 MHz digital storage oscilloscope provides a digitized display that will never fade or bloom. Selecting Roll mode yields a continually updated display of memory contents by providing a strip-chart-like view of signals at slow sweep rates. Applications range from measuring mechanical displacement transducer signals to biomedical activities. Option 10 GPIB Interface for I/O of stored waveforms and control of 5223 digital storage functions (except vertical and horizontal expansion and position controls). Waveform output format is selectable through this interface for either BINARY or ASCII. Plug-in functions not remotely controllable. See page 348.

7854 Waveform
Processing Oscilloscope*[1]

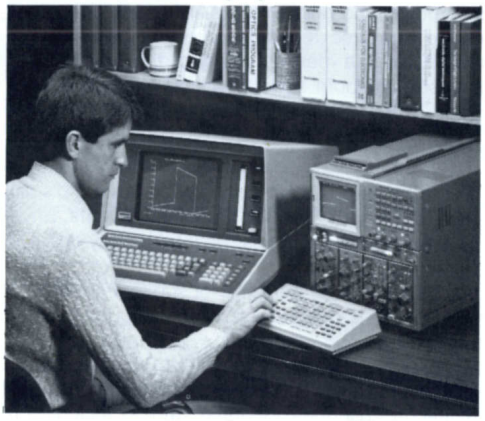
- 400 MHz Equivalent Time Bandwidth
- 10-Bit Vertical Resolution
- Pretrigger and Posttrigger
- Signal Averaging

A two-channel, waveform processing, digital storage oscilloscope. Keystroke programming of local keyboard and remote Waveform Calculator allows user-designed waveform measurement routines for tests or experiments. Signal averaging capability can recover signals buried in noise and improve measurement accuracy. All mainframe keystroke functions and operating modes can be remotely controlled via the GPIB. Plug-in functions not controllable via GPIB. See page 340.

[1] Remotely controllable.

WAVEFORM ACQUISITION PRODUCTS

Desktop Computer-Based Waveform Processing Systems



WP1310

Extended Waveform Processing; FFT and IFT
Mag Tape Program and Data Storage
High Resolution Graphic Display
GPIB Instrument Control

Based on the Tektronix 7854 Oscilloscope and the 4052A Desktop Computer System equipped with ROM packs, this system can acquire, process, store, and display electrical signals. 4050 Series BASIC routines from the Utility Software permit system operation with limited programming experience. The 7854 is remotely controllable over the GPIB. The 4052A can control other GPIB compatible instruments. See page 357.

WP2110

Acquisition to 200 MHz w/Program Control
Acquisition to 1 GHz w/Direct Access Plug-in
Program and Data Storage on Mag Tape
High Resolution Graphic Display
100 GHz Equivalent Sampling Rate
GPIB Instrument Control
Waveform and Array Processing

An effective combination of Tektronix instruments, the WP2110 is a high-speed, signal acquisition and transient digitizing system. Single-shot or repetitive signals from millisecond to subnanosecond duration can be digitized and stored with 9-bit resolution. Waveforms and arrays can be processed and displayed. The 7912AD is remotely controllable over the GPIB. See page 357.

WP3110

Acquisition to 80 MHz w/Program Control
Two Independent Digitizing Channels
Sampling Rates to 200 MS/s
High Resolution Graphics Display
GPIB Instrument Control
Waveform and Array Processing

Based on the Tektronix 7612D Programmable Digitizer and the 4052A Desktop Computer System equipped with ROM packs, the WP3110 is a complete signal acquisition, waveform processing, storage, and display system. Equipment options include a Hard Copy Unit. The 7612D is remotely controllable over the GPIB. The 4052A can control other GPIB compatible instruments. See page 357.

Controller-Based Programmable Digitizer Systems

WP2251/WP2252

Acquisition to 200 MHz w/Program Control
Acquisition to 1 GHz via Direct Access Plug-in
Program and Data Storage on Disk
Waveform and Array Processing
100 GHz Equivalent Sampling Rate
High Resolution Graphic Display

A self-contained signal acquisition, display, waveform processing, and data storage system, the WP2251 combines a Tektronix 7912AD Programmable Digitizer and an Instrument Controller with a 4012 Computer Display Terminal. Software support is TEK SPS BASIC and high-density data-storage peripherals. An extensive software package on disk includes signal processing, graphic and high-level GPIB driver in addition to instrument and system checkout programs. The Controller can accommodate up to four GPIB Interfaces and features 64 kilowords of memory expandable to 128 kilowords. See page 356.

The WP2252 is a complete acquisition, processing, storage, and display system for high-speed signals and transients. It is based on the Tektronix 7912AD Programmable Digitizer operating with a Controller, a Tektronix 4012 Computer Display Terminal and other peripheral equipment. TEK SPS BASIC software on (floppy) diskettes includes operational packages and checkout routines. The controller can accommodate two GPIB Interfaces and features 64 kilowords of memory and floating-point hardware. See page 356.

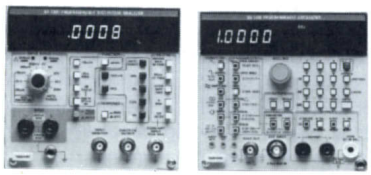
WP3201/WP3202

Acquisition to 80 MHz w/Program Control
Program and Data Storage on Disk
Sampling Rates to 200 MS/s
Waveform and Array Processing
Real Time GPIB Instrument Control
Two Independent Digitizing Channels

The WP3201 is a complete signal acquisition and waveform processing system based on the Tektronix 7612D Programmable Digitizer and a Controller. It is supported with TEK SPS BASIC software and high-density data storage peripherals. Stored on mag disk, resident software includes signal processing, graphics, and high-level GPIB driver in addition to major instrument and system checkout software. The Controller accepts up to four GPIB Interfaces. See page 356.

The WP3202 can acquire, process, and store high-speed signals and transients on two independent channels. This system combines the Tektronix 4012 Computer Display Terminal and 7612D Programmable Digitizer with a Controller and other peripheral instruments. Operating software contained on (floppy) diskette includes signal processing, graphics, and a GPIB driver in addition to instrument and system checkout software. The controller will accommodate two GPIB Interfaces and features 64 kilowords of memory and floating-point hardware. See page 356.

GENERAL PURPOSE INSTRUMENTS

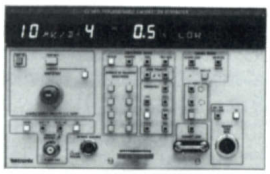


NEW **AA 5001/SG 5010 Programmable Audio Test System*[1]**

Fast, Accurate, Repeatable Measurements
Automatic, Low-Cost Documentation of Test Results

Automatically performs such industry-standard tests as harmonic distortion to IHF A202, intermodulation distortion to SMPTE TH 22.51, DIN 45403, IEC 268.3, and IHF A202, frequency response to IHF A202, and noise or signal-to-noise ratio to IHF A202 ("A" weighting filter complies with ANSI specification S1.4 and IEC specification 179 for sound level meters). With the Option 02 capability of the AA 5001, noise measurements may be made to CCIR 468-2 and DIN 45405 standards. The SG 5010 also generates the burst signal for dynamic headroom tests. See page 367.

GENERAL PURPOSE INSTRUMENTS



CG 5001 Programmable Calibration Generator*1

Tests Oscilloscope Current and Voltage Accuracy to ±0.25%

Tests Markers and Slewed-Edge Timing Accuracy to ±0.01%

Verifies Scope Probe Accuracy

A microprocessor-based TM 5000 Series plug-in designed to be an integral part of a controller-based system for calibrating and verifying major oscilloscope parameters. Learn mode allows front panel control settings to be assimilated as program data by controller. All front panel settings are remotely controllable via the GPIB. Built-in self test routine is activated when power is applied. See page 398.

DC 5009 Programmable Universal Counter/Timer*1

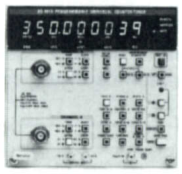
Frequency and Period to 135 MHz

Auto Trigger, Averaging, Self Test

10 ns Clock, Ratio Architecture

Trigger Level and Shaped Outputs

This dual-channel, microprocessor-based TM 5000 Series plug-in provides frequency and period measurement to 135 MHz and features push-button automatic trigger-level setting and 8 measurement functions. An arming input permits measurement of selected events within complex waveforms. Option 01 provides an oven-controlled 10 MHz crystal oscillator. All front panel settings and features are remotely controllable over the GPIB. See page 362.



DC 5010 Programmable Universal Counter/Timer*1

Dc to 350 MHz

Auto Trigger, Auto Averaging

3.125 ns Clock, Ratio Architecture

Arming Input and Shaped Outputs

A dual-channel TM 5000 Series plug-in that provides measurement of frequency to 350 MHz, period, ratio, and event B during A, using a reciprocal technique. Trigger levels automatically set to optimum. Trigger voltage setting is displayable. Automatic self-test feature. Probe compensation feature allows quick and accurate compatibility of signal probes. Remotely controllable over and fully programmable via GPIB. See page 360.

DM 5010 Programmable Digital Multimeter*1

4.5 Digit, 0.015% Accuracy

Automatic Self Test, Math Functions

In-Circuit Resistance Measurements

Autoranging

This remotely controllable, TM 5000 Series plug-in measures dc and true RMS ac voltages and resistance. A diode-test function tests semiconductor junctions while a low voltage/ohms function allows in-circuit measurements without turning on diode or transistor junctions. Math functions include: Averaging (up to 19,999 readings), dB (ref to 1 mW or to user-supplied constant). Comparison (user-supplied upper/lower limits). Offset and Scaling (user supplied constants), or any combination of these functions. See page 364.

FG 5010 Programmable Function Generator*1

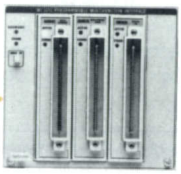
0.002 Hz to 20 MHz ±0.1%

20 mV to 20 V p-p From 50 Ohms

AM, FM, and VCF Modes

Auto Scan Phase Lock

This TM 5000 plug-in outputs Sine, Square and Triangle waveforms. Pulses and Ramps are provided with variable symmetry in one percent steps. Phase-lock mode automatically locks to any input signal, 20 Hz to 20 MHz. Dc offset voltage is programmable from 20 mV to 7.5 V. Can store ten front panel setups to reduce programming time. Fully programmable via GPIB. See page 365.



MI 5010 Programmable Multifunction Interface*1

Development Card

16 Relay Scanner, 10 Low Level Relay Scanner

16-Bit & 16 kb Digital I/O

12-Bit D/A & A/D Converter

This TM 5000 Series plug-in interface module accommodates 3 front-panel plug-in cards. The MX 5010 Multifunction Interface Extender provides space for 3 additional cards. A total of 6 function cards can be remotely controlled via the GPIB. Each of the 7 types of function cards includes its own ROM and specific function-related firmware. See page 369.

NEW **PS 5004 Programmable Precision Power Supply*1**

0 to 20 V Floating Output

0.5 mV/0.1 mA Resolution

Constant Voltage or Constant Current with Autocrossover

Voltage and/or Current Monitoring Display

This TM 5000 Series plug-in provides the high-resolution voltages and currents necessary in the characterization of transistor, IC, and other semiconductor and hybrid circuits and in the operation of high-performance strain gages and other transducer systems. Its entire 0 to 20 V output is covered with a coarse and fine adjustment to provide rapid setability and ±0.5 mV resolution without the necessity of changing ranges. The supply output is available at the rear interface as well as from the front panel terminals. Overall accuracy is ±0.01% ±2 mV. See page 366.

PS 5010 Programmable Triple Power Supply*1

Triple Output, Triple Display

Programmable Voltage & Current Limit

Front/Rear Outputs, Remote Sense

This TM 5000 plug-in provides three concurrent outputs; two floating at 0 to +32 and 0 to −32 V dc and a logic level suppply at 4.5 to 5.5 V dc. Operation includes auto-crossover with bus interrupt on continuous-voltage or continuous-current mode change. All three supplies may be remotely controlled over the GPIB while front panel settings are locked out. Overall accuracy is ±(0.5% + 20 mV). See page 366.

SI 5010 Programmable RF Scanner*1

Software Configurable

Sixteen 50-Ohm Signal Channels

Realtime Clock, 350 MHz Bandwidth

Stores 80 to 300 Commands

This TM 5000 Series plug-in uses sixteen RF reed relays to interconnect twenty front-panel BNC connectors in three possible combinations; four groups of four channels, two groups of eight, or one group of 16. Risetime for groups of four channels is approximately one nanosecond. Used for scanning and channel switching, this device is remotely controllable over the GPIB. See page 372.

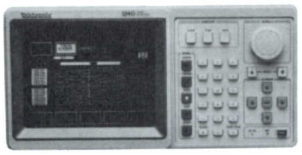
*1 Remotely controllable.

LOGIC ANALYZERS

DAS 9100 Series
Digital Analysis System*[1]

- Up to 104 Channels of Data Acquisition
- Acquisition Speeds to 660 MHz (1.5 ns)
- Up to 80 Channels of Pattern Generation at 25 MHz
- Color CRT Enhanced User Interface
- Easy-to-Use Menu-Driven Interface

A general purpose, configurable, and user-upgradable digital analysis instrument system. Available with black and white display (9109 Option 06 mainframe), without display (9119 mainframe) or with color display (9129 Option 06 mainframe). All of the functions that can be accessed from the DAS 9100 Series keyboard may be controlled via GPIB. The new I/O Option 06 supports GPIB data rates up to 200 kbytes per second as well as RS-232, serial line printers, hard copy units and master/slave operation. See catalog description for list of Data Acquisition and Pattern Generation Modules, accessories and probes. See page 64.



NEW **1240 Logic Analyzer**

- Up to 72 Acquisition Channels
- Acquisition Speeds to 100 MHz Async, 50 MHz Sync
- Dual Time Base Acquisition and Display
- Simple Menu Operation With On-Screen Soft Keys

The 1240 supports all aspects of the design task, including hardware analysis, software analysis, and integration. For hardware analysis, the 1240 offers up to 36 channels of 100 MHz acquisition with 6 ns glitch detection. Software analysis is supported by up to 72 data channels at sampling rates of 50 MHz synchronous/asynchronous. A flexible clocking scheme includes data demultiplexing on each acquisition probe. Acquisition, triggering and display of 2 independent time bases are tied together, so you can fully monitor the interaction between hardware and software. See page 70.

SYSTEM CONTROLLERS

4041 System Controller

- 16-Bit CPU Based on 68000
- 32 k RAM, Expandable to 160 k
- 48-File Mag Tape Drive
- Full Duplex, Asynchronous, RS-232 Interface
- Modmodular Design, Rackmount or Portable

A powerful and expandable, systems controller intended principally for execute-only environments such as production-line testing. Operating parameters include Interrupt and Error Handling modes. Options and peripherals equip it for interactive flexibility in research lab applications. Programming language is BASIC with English-like commands, extensions, simple syntax, and line-by-line interpreter. A 1.8 lines/second thermal printer is built-in. See page 331.

4051 Desktop
Computer/System Controller

- LSI, 8-Bit CPU
- 10 or 20 User-Definable Function Keys
- High-Level BASIC Programming Language
- High-Resolution Graphics and Alphanumerics
- 16 kb or 32 kb Memory Workspace

Provides stand-alone, integrated computing power for various problem solving and data analysis applications. Simple English-like BASIC commands provide friendly, flexible graphics capabilities. Built-in mag tape drive has 256 bytes with header. A GPIB Enhancement ROM Pack (4051R14) improves the performance of the 4051 as a controller. 12 commands facilitate standard GPIB commands using direct call statements; twelve more improve GPIB polling by adding parallel polling, control of SRQ sensing, automatic serial polling and decoding of Tektronix Codes and Formats for standard error messages. 17 additional commands expand binary data acquisition and automated data acquisition and manipulation. See page 128.

4052A Desktop
Computer/System Controller

- Extended BASIC Programming Language
- Memory Expandable to 64 kb
- LSI, Bipolar, 16-Bit CPU
- 10 or 20 User Definable Function Keys
- High Resolution Graphics

This system controller offers high-performance, stand-alone computing power, flexible data communications, and easy-to-learn extended BASIC. Excellent choice for scientific/statistical research, forecasting, data acquisition and analysis. Processor uses microcode floating point and built-in mag tape drive allows easy storage of ASCII and binary programs and data. A GPIB Enhancement ROM Pack (4052R14) provides additional capabilities similar to those indicated for the R4051R14 above. See page 129.

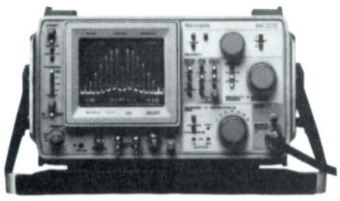
4054A Desktop
Computer/System Controller

- 19-Inch, High-Resolution Display
- LSI, Bipolar, 16-Bit CPU
- Extended BASIC Programming Language
- Dynamic Graphics Option
- Color Enhanced Graphics Option
- 32 kb or 64 kb Memory Workspace

Unequaled graphics in an integrated desktop computer/system controller. Microcoded floating point processor for rapid calculation. Software is compatible with entire 4050 Series including PLOT 50 Graphics. With 4096 X and 3120 Y resolution (12 million addressable points) the 4054A has the graphics capability for even the most complex displays. A GPIB Enhancement ROM Pack (4052R14) provides additional capabilities similar to those indicated for the R4051R14 above. See page 130.

[1] Remotely controllable.

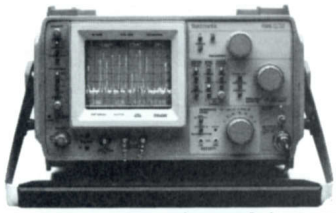
SPECTRUM ANALYZERS



492P Programmable Spectrum Analyzer*[1]

Digital Storage and Signal Processing
80 dB Dynamic Range
Amplitude Comparison in 0.25 dB Steps
100 Hz Resolution Bandwidth

A portable, 50 kHz to 220 GHz, lab quality analyzer that provides CRT readout of all important front panel settings and is fully calibrated in amplitude and frequency. Front panel adjustments can be remotely controlled over the GPIB for automated spectrum analysis via GPIB. Features microprocessor-aided, three-knob operation and flicker-free display even at the slowest sweep speeds. See page 211.



496P Programmable Spectrum Analyzer*[1]

Digital Storage and Signal Processing
1 kHz to 1800 MHz Input Frequency
80 dB Dynamic Range
Amplitude Comparison in 0.25 dB Steps
30 Hz Resolution Bandwidth

Providing a CRT display of all important control settings, this 1800 MHz analyzer features microprocessor-aided, three-knob operation and automatic mode selection. Unit is fully calibrated in frequency and amplitude. Front panel settings can be remotely controlled. Digital storage eliminates time consuming display adjustments. See page 215.

PERIPHERALS FOR IEEE-488 SYSTEMS

4663 Interactive Digital Plotter*[1]

Multi-Color Capability
Dual-Programmable Pen Control
9 Character Fonts
5.5 k Buffer Memory

This intelligent plotter has a unique front panel device that allows quick selection of operating parameters. Selections can be stored up to 90 days without power. Plots on C-size (European A2-size) paper, mylar, or acetate film with felt-tip, hard-nib, or wet-ink pens. Compatible with PLOT 10 Graphic software. Fully programmable via GPIB. See page 137.

1360P/1360S Programmable Signal Multiplexer*[1]

3 ms Maximum Switching Time
Dc to 250 MHz Bandwidth (1 switch)
Input Levels up to 250 V dc or 250 mA
Expandability up to 4 Switch Modules

A microprocessor-based, programmable, system instrument that can be used to multiplex electrical signals. Switch matrix includes four identical, nine-pole coaxial switches. Operational modes determined by adjustable straps. Switch modes are: individual gangs of 1, 2, or 4. Multiples of eight inputs can be multiplexed to one output. Remotely controllable over the GPIB. See page 372.

4909 Multi-User File Management System*[1]

32 or 96 Mb Drive Capacity
Expandable Up to 8 Drives (768 Mb)
Indexed and Dynamically Allocated Files
Variable Length Records
Time of Day Clock with Battery Backup

A high performance mass storage system with flexible file management and a multiple-level library structure. 4909 features include data protection, indexed files, and automatic self-test with LED fault indicators. In addition to the cabinet, the standard system includes a controller that can manage up to ten desktop computers, one 32 Mbyte disk drive, a disk interface plug-in, and an IEEE-488 Interface plug-in. Up to 10 users can share access, with public and private file workspace for operational flexibility and file protection. See page 132.

4932/4909F02 GPIB Extender

Up to 500 Meter GPIB Extension
User Transparent Operation
4909 Plug-in Option
Low Unit Price, Low Cost Cable

Provides GPIB communication over distances of up to 500 meters (1650 feet) by converting parallel GPIB data to serial form, appending various control signals, and transmitting data to the remote end over 75 Ω RG 6/U coaxial "link" cable. See page 132.

[1] Remotely controllable.

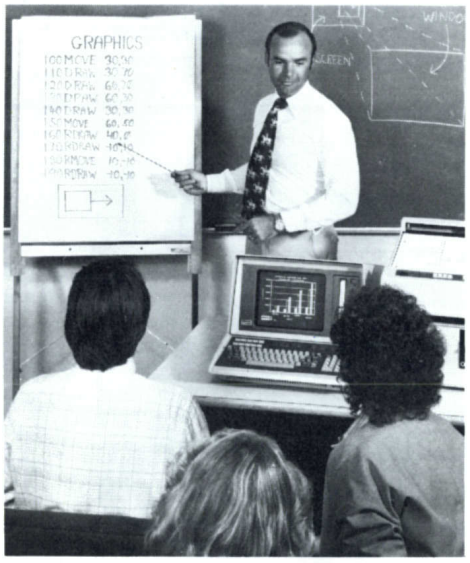
RECOMMENDED GPIB CABLES

Part Number	Description
012-1015-00	0.5 meter, single shield
012-0991-01	1 meter, double shield, low EMI
012-0991-00	2 meters, double shield, low EMI
012-0991-02	4 meters, double shield, low EMI

CUSTOMER SERVICES AND INFORMATION

CONTENTS

Sales Information and Assistance 36
User Assistance 36
Product Characteristics 37
Terms of Sale 37
Worldwide Service Support 38-39
Warranty Statement 40
Warranty-Plus Service Plans 41
OEM Information 42
Sales and Service Offices . Inside Back Cover



The people behind the product are friendly and ready to help you.

Get sales information and assistance to evaluate and order the products you want.
Ask for a Customer Service Representative the first time you contact Tektronix. The CSR can give you information on products and the names of the Sales Engineers assigned to serve your product interests. Tektronix Sales Engineers will respond to your technical and business inquiries.

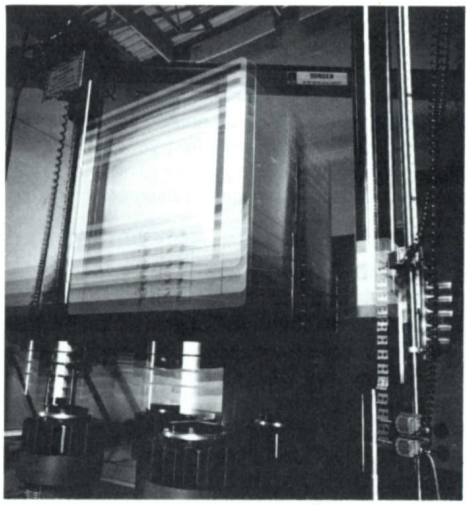
Sales Engineers can give you information on dozens of products, so that you can select the one model best suited to your present and future applications, and will be happy to arrange a demonstration of that product.

Your Customer Service Representative or Sales Engineer can provide you with information on prices, terms, delivery dates, shipping estimates and best means of shipping.

Customer-site installations are thorough.
Tektronix provides on-site installation for most computer graphics products and most Tek-configured systems for computer graphics, semiconductor test, microprocessor development, and signal processing. The Tektronix service specialist will make sure your equipment is set up properly with all functions operating to spec, and will walk you through the basics of its performance.

Training and assistance gets users up to speed, fast.
Your Tektronix product is most useful to you when you're thoroughly familiar with it. Ask your Sales Engineer for a demonstration. If several people plan to use the products, your Sales Engineer will conduct an informal class about the product and its operation at your location. Tektronix also offers formal classes and self-study aides. Ask your Sales Engineer for details about Customer Training.

Check the Specifications. You'll Find Long Product Life Designed-In.



Reliability Standards Second to None

Tek products are engineered for high reliability from the initial stages of design. Components and assembled products of every prototype and preproduction model are subjected to "accelerated-life" reliability tests in our Labs. If any fall short of Tek Standards, changes are made.

Manufactured products are thoroughly tested before they're fitted in custom-designed, lab-tested shipping cartons.

Product Specifications to Meet Your Environment

In Tek's Environmental Labs, field conditions are taken to extremes. Shock, vibration, high humidity, electromagnetic radiation, electrostatic discharge, power line surge, high/low temperature and altitude tests are conducted.

The environmental characteristics listed among the product specifications in this catalog may include some or all of the above types. The specification limits for humidity, vibration, shock and transportation are intended to be beyond what is expected in use. Operation at these extremes may cause minor physical deterioration but should not cause electrical performance to deteriorate outside specifications. Continual use at the specified limits of temperature and altitude should not cause significant short-term deterioration. Higher temperature will reduce long-term reliability. The EMC test is completely nondestructive.

GENERAL TERMS OF SALE

Credit and Payment Terms

Tektronix, Inc. offers many different terms of sale in order to meet varied purchasing objectives and to assist in financial planning.

Credit accommodations must be arranged with Tektronix's Credit Department. Orders and request for credit accommodations should be placed with your local Tektronix Sales Office, listed on the inside back cover.

If, in the judgement of Tektronix, the financial condition or payment record of the Buyer at any time does not justify shipment of order on the payment terms requested, Tektronix may refuse to ship unless it receives payment in advance, or at its option, payment upon delivery of equipment. Businesses established for six months or less may not meet minimum requirements for extended and/or installment terms of sale.

The following terms may be arranged with a Tektronix Sales Office:

Net 30 Days Standard Terms

Standard terms of sale are Net 30 days following the date of invoice. There are no discounts for early payment.

60, 90 and 120 Days Extended Terms of Sale

Extended terms of 60 to 120 days are available on the same single payment basis as standard terms. Since the cost of extended terms is not included in catalog prices, a service charge is added to the invoice. The amount of the service charge depends upon the number of days the terms are extended. Request for extended terms must be made at the time of order placement.

Installment Purchases—Security and Lease Agreements

This program provides monthly installment payment terms while Tektronix Products are in use. Accessories and parts are not available unless they are associated with the products being purchased. New and used products may be purchased with a deduction for applicable quantity discounts.

Security and Lease terms are not invoiced. Reminders of each installment are sent to the customer 10 days prior to the due date. The due date of each monthly payment on an installment term will be approximately 30 days from the date of shipment and every 30 days thereafter until completion of the contracted term. Failure to receive any reminder notice from Tektronix shall not affect customer's obligation to pay charges when due.

Except for standard warranty, maintenance is not provided under either a Security Agreement or a Lease Agreement. Additional maintenance is not provided under either a Security Agreement or a Lease Agreement. Additional maintenance coverage may be purchased where offered as an option to the instrument or may be purchased as a separate transaction. Maintenance ordered as an option may be financed along with the product.

The customer is required to pay applicable property taxes, licenses, etc. and furnish adequate insurance to Tektronix for loss and damages for both Leases and Security Agreements.

Security Agreement

An advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a Security Agreement. Installment terms covering the balance of the contract price are available for 6, 12, 18, 24, 30, or 36 months.

Minimum balance amounts may be financed, ranging from $1000 for six months to $2000 for thirty-six months. Longer terms of 48 months to 60 months are available by quotation for financed balances of more than $25,000. There are no maximum finance balances. Upon completion of the term of the Security Agreement and prescribed payments, the customer owns the equipment.

Lease Agreement (Minimum is $1,000)

A standard lease term of 6, 12, 18, 24, 30, and 36 months is offered. Longer terms are negotiable. Under a Lease Agreement the customer pays for the use of the product for the term of agreement. It is not a month-to-month rental . . . it is a non-cancellable, fixed-term lease requiring no advance payment. At the expiration of the lease there is the opportunity to update the instruments, to renew the existing lease, or to return the equipment at the expense of Tektronix, Inc. The customer may exercise an option to purchase the equipment at any time during the term of the lease, provided he gives thirty days written notice. A portion of the installments will be credited toward the purchase price.

Computer Graphics Products

Most Computer Graphics Products are also available under an operating lease program. The minimum fixed terms of this program are 12, 24, 36 months, or longer. Automatic extension on a month-to-month basis is also available after the fixed minimum term. Equipment leased on this program is maintained by Tektronix, Inc. during the terms of the agreement. Rental of Computer Graphics Products for customer evaluation is available for periods of 90 or more days.

During the term of the operating leases or rentals described, the customer may exercise an option to purchase the equipment provided 30 days notice is given. A portion of the installments already paid will be credited toward the purchase price. Questions regarding warranty should be discussed with your Tektronix Sales Engineer.

Minimum Order

The minimum acceptable order is $25.00.

Shipment

All prices, quotations, and shipments are FOB Beaverton, Oregon, unless otherwise specified.

Unless otherwise specified, shipment will be made via most economical methodand air shipments will be insured at full valuation unless your order instructs otherwise.

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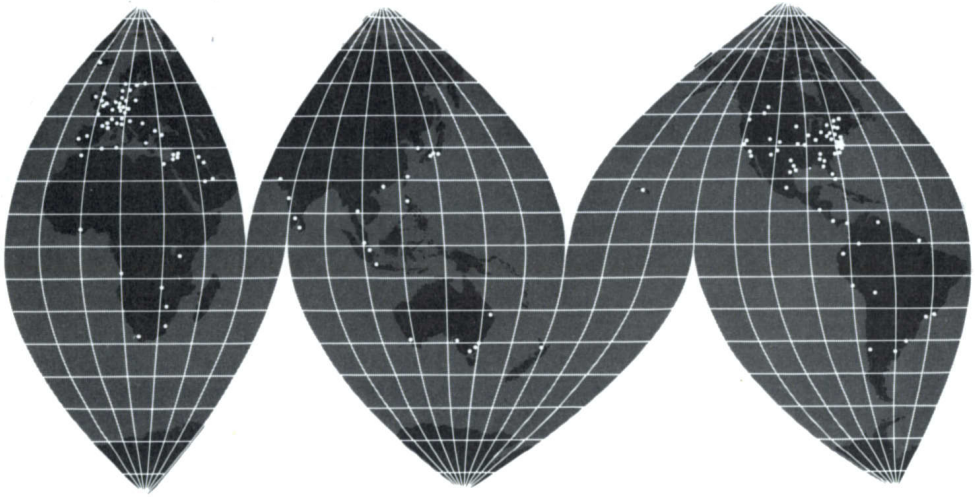
Quality Service. Quick Response. Tailored to Your Needs. Worldwide.



Quality First, For Performance That Lasts.

Tektronix has a reputation for producing reliable products and supporting those products with a dedicated service organization for over 35 years. We know that fast, fixed-the-first-time service is important to you. Tek stands ready to help you receive the highest return for your equipment investment.

Service Around the Globe.

Our worldwide service network, shown above, offers technical back-up to keep your Tektronix products and software running as reliably as the day they were installed. Tektronix products are supported by 85 Service Offices in over 60 countries.

Some 1,400 people are exclusively dedicated to servicing Tektronix products. Tek Service Specialists are thoroughly trained professionals. To support their efforts, Tek has made a major investment in facilities and equipment, including our own state-of-the-art diagnostic equipment of both local and remote, and maintains a computer-controlled inventory of genuine Tek parts to ensure local availability.

NEW Service Agreements Provide the Fastest Service for Maintenance, Calibrations and Repairs.

The planned program of regular service provided by Tek Service Agreements reduces the chance that your equipment will fail and keeps it operating to published specifications. No matter which type of Tek Service Agreement you choose, priority service and savings over single-instance, time and materials service are assured.

Select the Service Agreement that Fits Your Needs.

The next time you purchase a Tek product, ask your Sales Engineer about the ***Warranty-Plus*** Service Plans described on page 41. They are by far your best service value, and are available only when you buy your product.

After delivery, choose a Customer-Site Service Agreement for information display products and Tek-configured systems for microprocessor development, signal processing or semiconductor tests. Tailor it to meet your response time requirements.

For television equipment and test-and-measurement instruments, you can select from five types of Service Center Support Agreements. Get as much coverage as you need. Pay only for the coverage you select. We offer an "early sign-up" discount if you get your service agreement while your equipment is covered under New Product or Service Warranties.

Quantity discounts are also available under both types of agreements. Ask your Service Specialist for details about coverage and discounts.

NEW Annual Customer-Site Support Agreements.

Maintenance Agreements are available for Tek-configured systems and all information display products. Our customer-site response target is "same day service," within eight-workhours with few exceptions. Our objective is to maximize your uptime. For faster response, multishift or weekend coverage, ask about our service agreement options. We want your business and we're flexible.

The service agreements cover: parts, labor and travel. To replace a CRT or simply adjust it. And to further minimize downtime, Customer-Site Agreements include the appropriate number of annual planned maintenance calls for your product. Our inspections and parts replacements, including CRT, are thorough. We give meticulous attention to such details as optimized fine-tuning, cleaning, and making sure operation has been restored to your satisfaction before leaving your area.

NEW Annual Service Center Support Agreements for Instrumentation and Television Products.

Calibration/Performance Test Support. Includes one CAL/PT, plus minor cosmetics and cleaning work.

Standard Support. Includes one scheduled CAL/PT repairs, plus a CAL/PT (if needed) with each repair. All labor, parts—*except CRT*—to restore operation to published specs in event of failure, modifications to update reliability, and minor cosmetics/cleaning.

Total Support. Includes all Standard Support coverage, plus all parts—*including CRT replacement.*

Basic Support. Includes repair and CAL/PT to published specs at the time of repair following failure. Labor, parts and reliability mods. Scheduled CAL/PTs and CRTs are not included.

Remedial Support. Includes restoration of the product to functionality in the event of failure *without CAL/PT.* Mod installation is limited. Includes labor, parts, (except CRT), and minor cosmetics and cleaning.

Add-on Support Services. With Total, Standard and Calibration Agreements, you may opt for additional calibrations, recall programs, NBS certification, or before-and-after test documentation. Pick up and delivery are also available at selected locations.

NEW Firm Price Schedule on per-incident repairs and calibrations.

Ask your Service Center Specialist for a FIRM PRICE SERVICE SCHEDULE. It gives you the exact cost, in advance, to calibrate or performance test, repair, or repair with CAL/PT most Tek Instrumentation Products at the Service Center. If it takes less than an hour's labor and under $10 in parts for the repair, only the Mini-Repair Fee is charged. And all *Firm Price* Services are warrantied for 90 days. You can sign-up for some service agreements during this period and receive an "early sign-up" discount.

Responsive Customer-Site Per-Call Service.

Fast service is available for Tek-configured systems and most computer graphics products on a time and materials plus travel basis. The same quality of service offered under Agreement coverage is provided and warrantied for 90 days.

Service Center Support for Damaged or Discontinued Products is Available.

Abused, damaged and discontinued products excluded from the *Firm Price* Program and per-call service may be repaired on a time-and-materials basis. Please obtain instructions from your nearest Tektronix office before returning equipment or parts.

Long-term Product Support.

Our intent is to provide full service support for six years from the publication date of the catalog in which the product last appeared. Time and materials service, support agreements, FIRM PRICE repair and calibration services, together with the unique replacement parts needed, will be available to preserve your equipment.

For the following three years we plan to provide full support and parts, though service may be limited to designated Service Centers and take longer to complete.

After nine years we will use our best efforts to continue support if experienced technicians and the necessary parts are available.

Self-Maintenance Support.

We support the efforts of customers who choose to perform their own maintenance.

Parts. For the fastest possible service, phone the part name, product model and serial numbers to the Tektronix Direct Parts Order Desk for your area. (See map for toll-free numbers. Outside the continental United States, contact your nearest Tektronix Sales and Service Office.)

Module Repair and Return. Specified modules for information display products and Tek-configured systems may be sent to our Factory Service Center in Beaverton, Oregon for repair. Turnaround is good on this cost-effective and, for many self-maintenance customers, convenient means of service.

Provisioning (Service Spares). To assure you of an efficient inventory of stock on hand, Tektronix will recommend packaged spares for individual products or product groups (based on experienced field failure data) and provide them according to your specifications.

Service Training. You can learn from Tektronix. We've established a comprehensive Customer Service Training Program of classes and self-study aides on subjects such as instrument operation, circuit description, calibration, basic concepts and applications. Formal classroom training is offered at several Tek locations around the world. In some cases, training can be arranged at your site. You may also order from our library of independent study aids. Audiotapes, videotapes, and printed materials are available. Just obtain a copy of our CUSTOMER SERVICE TRAINING CATALOG from your nearest Tektronix Office or by completing the reply card in this catalog.

Service Publications. For every Tektronix product there is a Service Manual with circuit schematics, parts lists, operating, maintenance and troubleshooting information. Order as you would for any part. You can receive our periodic newsletter on service, TEKNOTES, by asking your Tektronix Representative. We also offer subscriptions to service information, updated quarterly, on ANSI standard 105 mm x 148 mm negative microfiche. Manuals, data sheets, reference cards and mod update information are also available.

Software Support.

Archieve System Productivity Goals Quickly with Tek's Technical Assistance Services (TAS).

We'll provide short-term, on-site consultation to help you implement Tektronix software, train users, and solve application problems. A Tektronix System Analyst is available to help define the scope of assistance needed before any cost is incurred.

Software Subscription Services (SSS) Keep Your Programs Current.

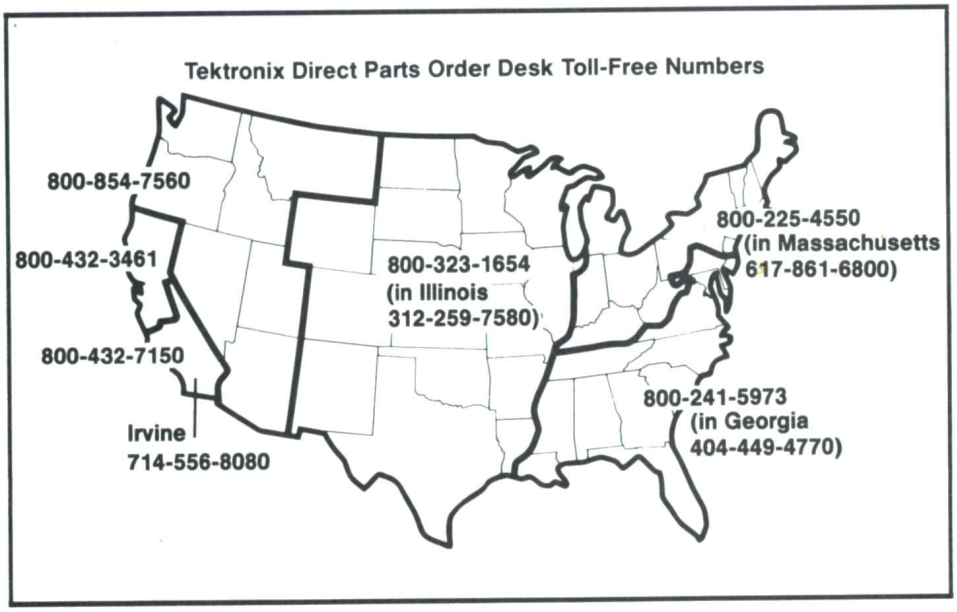
Subscribers to SSS receive the most current releases of Tektronix licensed software products, and updates to software documentation. SSS is available at the time you order new software. If you subscribe at a later date, you'll receive the latest release of your original software.

International Service Offerings

Not all countries offer all programs discussed here. Contact your local Tektronix Sales or Distributor's Office for specifics.

Tektronix is flexible and dedicated to quality service.

If you have special requirements not mentioned here, we want to know. Customer satisfaction and quality service are high priorities and integral parts of our commitment to excellence. No matter where in the world your work takes you, Tektronix is with you all the way.



For your convenience, you may order parts directly by calling the desk at the toll-free number for your area.

HARDWARE WARRANTY SUMMARY

Tektronix warrants to its Customers that the products that it manufactures and sells will be free from defects in materials and workmanship for the periods set forth in the table below. If any such product proves defective during the applicable warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Tektronix will provide such service at Customer's site for certain categories of products, as indicated in the table below, if Customer's site is within the normal on-site service area. Tektronix will provide on-site service outside the normal on-site service area only upon prior agreement and subject to payment of all travel expenses by Customer. In all other cases, Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the service center is located. Customer shall be responsible for paying all shipping charges, duties and taxes, if the product is returned to any other location. The locations at which the services will be provided for different categories of products or product groups are set forth below.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modiified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE LISTED PRODUCTS IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE A DEFECTIVE PRODUCT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX HAS ADVANCE NOTICE OF THE POSSIBLITY OF SUCH DAMAGES.

PRODUCT CATEGORIES	WARRANTY PERIOD	SERVICE LOCATION
Oscilloscopes (except 22xx,23xx,24xx) and Plug-ins; General Purpose Instruments; Data Communications Analyzers; Logic Analyzers; Spectrum Analyzers; Television Products (except 1980); Waveform Digitizers; Cameras; Carts; Probes; CRTs; and Isolators	1 year from date of shipment	Service Center designated by Tektronix
Oscilloscopes: 22xx,23xx,24xx Series	3 years from date of shipment	Service Center designated by Tektronix
Display Monitors: 602,603,606,608,620,624,634,614,616	3 months from date of shipment; except 1 year from date of shipment for CRT	Service Center designated by Tektronix
Computer Graphics Products (except 4105,4107,4109); Microcomputer Development Products: 1980	3 months from date of shipment; except 1 year from date of shipment for CRT	Customer's site if within normal on-site service area
Computer Graphics Products: 4105,4107,4109	1 year from date of shipment	Customer's site if within normal on-site service area
Signal Processing Systems; Semiconductor Test Systems	3 months, except 1 year for CRT, beginning on the date of installation or one month after shipment, whichever is earlier.	Customer's site if within normal on-site service area

SOFTWARE WARRANTY SUMMARY

Tektronix warrants that any software product for which Tektronix publishes a corresponding "Software Product Description" will conform to the specifications set forth in the Software Product Description, when used properly in the specified operating environment, for a period of three (3) months. The warranty period begins on the date of shipment, except that if the program is installed by Tektronix, the warranty period begins on the date of installation or one month after the date of shipment, whichever is earlier. If any such software product does not conform as warranted, Tektronix will provide the remedial services specified in the applicable Software Product Descriptions. Tektronix does not warrant that the functions contained in the software product will meet Customer's requirements or that operation of the programs will be uninterrupted or error-free or that all errors will be corrected. Software products for which Tektronix does not publish a Software Product Description, or for which Tektronix does not set forth specifications in the Software Product Description, are provided "as is" without warranty of any kind, either express or implied; except that, Tektronix warrants that the media on which such software products are provided will be free from defects in materials and workmanship for a period of three (3) months from the date of shipment. If any such medium proves defective during this warranty period, Tektronix will provide a replacement in exchange for the defective medium.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for such service in accordance with the instructions received from Tektronix. If Tektronix is unable, within a reasonable time after receipt of such notice, to provide the remedial services specified in the applicable Software Product Description, when such services are indicated, or provide a replacement that is free from defects in materials and workmanship, Customer may terminate the license for the software product and return the software product and any associated materials to Tektronix for credit or refund.

This warranty shall not apply to any software product that has been modified or altered by Customer. Tektronix shall not be obligated to furnish service under this warranty with respect to any software product a) that is used in an operating environment other than that specified or in a manner inconsistent with the User's Manual and documentation or b) when the software product has been integrated with other software if the result of such integration increases the time or difficulty of analyzing or servicing the software product or the problems ascribed to the software product.

TEKTRONIX DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO PROVIDE REMEDIAL SERVICE WHEN SPECIFIED, REPLACE DEFECTIVE MEDIA, OR REFUND CUSTOMER'S PAYMENT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

For further details regarding OEM or specific product warranties, please consult your local Sales Office.

NEW ***Warranty-Plus*** **is Your Best Service Value.**

We offer *Warranty-Plus* because we want to be sure you get full value for your investment from the start. That means maximum uptime long after your warranty expires.

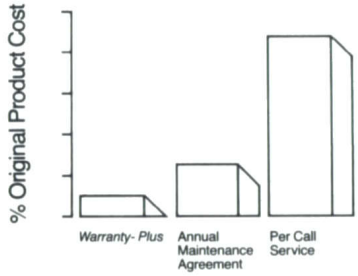
The relatively low cost of *Warranty-Plus* Options reflect our confidence in the high reliability of our products. And, unlike annual maintenance agreements, there is only one *Warranty-Plus* price per product with no additional charge for the extra equipment options you may select.

Ask your Tektronix Sales Engineer or Customer Service Representative for prices. You will discover that, compared with annual maintenance agreements or per-call service, calibrations or repairs. *Warranty-Plus* is now your most cost-effective means of service. You'll also save money because *Warranty-Plus* limits your costs, no matter how much service rates may increase.

You'll get more uptime, too, because with *Warranty-Plus* you won't experience delays in needed service because of unplanned expense, approvals, or paperwork.

Warranty-Plus helps you manage your maintenance costs with just one, up-front product option charge. Pay it with your purchase. Forget about service costs for one year or, in some cases, up to five years. Nothing makes budget planning easier.

Relative Maintenance Cost



Ask your Tektronix Sales Engineer for the Warranty-Plus option. It's only available at the time you purchase, but it is, by far, your best service value.

Warranty-Plus **Customer-Site Support Option N1.**

For about the cost of one customer-site service call, you can extend 90-day service coverage on most Information Display Products to a full year. Just request *Warranty-Plus*, Option N1, at the time you place your product order. It covers travel, modules, all parts (including CRT) and labor to keep your equipment functioning to published specs for one year. Plus the appropriate number of planned maintenance calls to inspect, test, clean and adjust your equipment to optimum performance. This includes maintaining mechanically-based copiers, plotters and disk drives as well as adjusting sharpness, resolution or convergence of DVST and raster CRTS.

Warranty-Plus Option N1 is only available with standard end-user sales of most information display products, and only at the time of product purchase. Specify "Option N1" when ordering.

CUSTOMER SITE SERVICE FOR MOST INFORMATION DISPLAY PRODUCTS AND TEK CONFIGURED SYSTEMS

Month of Ownership	1 2 3	4 5 6	7 8 9	10 11 12
Warranty Only	Warranty Coverage			
Warranty-Plus Option N1	Warranty Coverage	*Warranty-Plus* Coverage Planned Maintenance Call(s)		

Warranty-Plus **Customer-Site Support Option N2.**

Our new 4105, 4107 and 4109 Color Terminals are so reliable that each is covered by a New Product Customer-Site Service Warranty for **one full year.** What's more, we're so confident of their reliability that we'll extend your coverage for **two more years** at a price so low it breaks industry barriers.

Customer-Site coverage for both the 2nd and 3rd year costs less than one average service call. Less than an annual service contract you may purchase later. And only a fraction of the standard, one-time repair-and-adjustment fee.

Warranty-Plus Option N2 covers travel, modules, parts, CRT, and labor.

Warranty-Plus Option N2 is only available on the 4105, 4107, and 4109 terminals and only at time of product purchase. Specify "Option N2" when ordering.

CUSTOMER-SITE SERVICE FOR 4105, 4107 and 4109 COLOR TERMINALS

Year of Ownership	1	2	3
Warranty Only	Warranty Coverage		
Warranty-Plus Option N2	Warranty Coverage	*Warranty-Plus* Coverage	

Warranty-Plus **Service Center Support Options.**

As strong testimony to the incomparable reliability of the 2000 Series of Tektronix portable oscilloscopes, Tek offers a **three year warranty**—the first of any major scope manufacturer to do so. Now, beyond the "basic three years"—Tek will extend service coverage up to five years, offering you a choice of three practical *Warranty-Plus* Service Center Support Options to meet your needs.

Warranty-Plus **Option M1**. Provides two routine calibrations to published specifications, one each in years two and three of Warranty coverage.

Warranty-Plus **Option M2**. Provides two years coverage of Remedial Service which includes repair service labor (except calibration) and parts (except CRT) in years four and five of product ownership.

Warranty-Plus **Option M3.** Provides for four years of routine calibrations, one each in years two, three, four, and five of product ownership. During years four and five, annual calibrations may be performed at the time of repair in the event of failure or at a scheduled date independent of repair per customer's request, but not both.

Optional *Warranty-Plus* Plans are only available on 2000 Family Portable Oscilloscopes and only at the time of product purchase. Specify "Option M1," "Option M2," or "Option M3" when ordering.

SERVICE CENTER SUPPORT FOR 2000 SERIES PORTABLE OSCILLOSCOPES

Year of Ownership	1	2	3	4	5
Warranty Only	Warranty Coverage			-----	
Warranty-Plus Option M1	Warranty Coverage -----	One Cal	One Cal	-----	
Warranty-Plus Option M2	Warranty Coverage			Remedial Coverage	Remedial Coverage
Warranty-Plus Option M3	Warranty Coverage -----	One Cal	One Cal	One Cal + Remedial Coverage	One Cal + Remedial Coverage

International ***Warranty-Plus*** **Options, Customer Responsibilities and Coverage Exclusions.**

Warranty-Plus is available in most countries, but service is only provided in the country where the product and plan are purchased. *Warranty-Plus* Service purchased in the United States is only valid within the United States.

In the United States, service is performed during normal business hours. For most Information Display Products or Tek-configured Systems, service is provided at the customer's site with no travel charges, within eight work hours of notification, if the site is within 150 miles of a Tektronix Service Center. If not, response may be longer.

Our 2000 Family Portable Oscilloscopes receive priority service at a Tek Service Center. Under Options M1, M2, and M3, it is the customer's responsibility to deliver the product for servicing at the Service Center designated by Tektronix, with shipping charges prepaid. Return shipping is also paid by Tektronix.

Outside the United States, response and turnaround times may be different. Consult the Tek subsidiary or approved distributor in your country.

As you may expect, service under a *Warranty-Plus* Agreement does not apply if the failure is caused by misuse or inadequate care or maintenance, such as:

a) damage from repair attempts by non-Tektronix personnel;
b) improper use or connection to incompatible equipment; or
c) modification or integration that increases time or difficulty in servicing your product.

OEM COMPONENTS

Special Information for OEM
At Tektronix we offer many products with terms, conditions, and pricing for OEMs. Computer graphics components, small screen displays, certain cameras, tv signal test and measurement instrumentation—we offer these and other products on a special basis to the original equipment manufacturer.

But terms and conditions tell only part of the Tektronix OEM story. Our products have the quality, reliability, and the top performance per dollar that the OEM needs to stay competitive.

Choose The Performance Level To Match Your System
In many product areas our wide range of OEM components allows you to select just the optimal performance you need for the system you are building. When your systems demand highest performance, Tektronix will provide the quality products to meet your standards.

In price-sensitive situations, the wide Tektronix selection usually lets you select exactly the performance level you need—no more, no less.

Special OEM Terms and Pricing Help Keep You Competitive
Ask your local Tektronix representative about the special OEM terms and pricing available to you.

Service and Support— When and Where You Need It
Tektronix has service centers throughout the U.S. and in many countries around the world. We offer long term parts support to protect your investment.

If you need applications assistance, we're ready to help. Our OEM specialists are trained to help solve interface problems. That's solid support when you need it.

You and Tektronix: A Quality Partnership
Explore the advantages of working with Tektronix: excellence in products, in support, and in service.

Your local Tektronix representative can help you get full details on how you can profit from a quality partnership with Tektronix.

See how our OEM expertise can add value to your system.

POWER SOURCE CONSIDERATIONS

Most Tektronix instruments provide wide-range regulated supplies, or quick change line-voltage selectors for convenient selection of line-voltage operating ranges. Transformer taps in other instruments can be changed to accommodate specific line-voltage operating ranges or can be factory wired for a specific range if specified on the purchase order.

Many Tektronix instruments are designed to operate from a power source that will not apply more than 250 Volts RMS between the supply conductors or between either supply conductor and ground.

Many Tektronix instruments can be fitted with one of the power cord/plug options listed below and wired for the voltage as indicated, if specified on the purchase order.

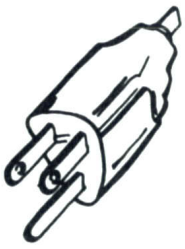
North American	120 V/15 A	Standard
Universal Euro	220 V/16 A	Option A1
United Kingdom	240 V/13 A	Option A2
Australian	240 V/10 A	Option A3
North American	240 V/15 A	Option A4
Switzerland	220 V/10 A	Option A5

The power cord/plug options may become available on instruments not specified in this catalog. Refer to the individual product ordering information for those products offering these options as of publication date.

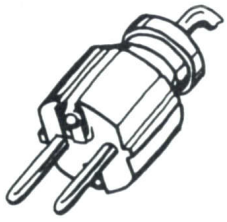
Except for some double-insulated instruments, most Tektronix instruments are equipped with either a three-conductor attached power cord or a three-terminal power-cord receptacle. The third wire or terminal is connected directly to the instrument chassis to protect operating personnel.

Power-cord coding follows one of the two following schemes:

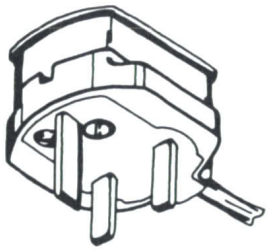
	Scheme 1	Scheme 2
Line	Black	Brown
Neutral	White	Light blue
Ground (safety earth)	Green-yellow	Green-yellow



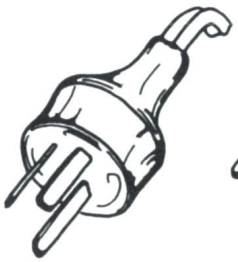
Standard
North American
120 V/15 A



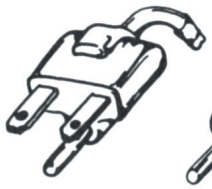
Option A1
Universal Euro
220 V/16 A



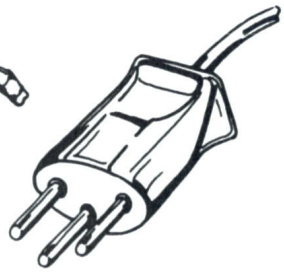
Option A2
UK
240 V/13 A



Option A3
Australian
240 V/10 A



Option A4
North American
240 V/15 A



Option A5
Switzerland
220 V/10 A

DESIGN AUTOMATION DIVISION

The Design Automation Division provides tools that support the evolving requirements of the electronic designer. A full line of interrelated products are offered which are used to help design, verify, integrate and test microcomputer and logic-based systems. These include the S-3295 VLSI Test System, models 318, 338 and 1240 Logic Analyzers, and the 8561 Multi-User Software Development Unit. Each of these recent additions to the Design Automation Division product line represents a Tektronix commitment to technical excellence, performance and value.

The Design Automation Division of Tektronix is a response to the far-reaching implications of LSI/VLSI technology. Since the advent of the microprocessor in the early 1970's, there has been a constant increase in both the variety and complexity of "intelligent" products under microcomputer-based control. Driving this trend is the increasing performance capacity of microprocessor hardware, exemplified by the jump from 8-bit to 16-bit microprocessors, and the recent emergence of 32-bit "micromainframes".

These advances in the hardware's performance capacity have had a profound effect on the way that new digital products are conceived and designed. More powerful hardware opens the door to more sophisticated products, which in turn generate more demanding product specifications. Consequently, the task of designing digital products has grown larger and more complex.

This ongoing expansion of the digital design task has created the need for a new approach to microcomputer design instrumentation, one that ensures the designer can maintain maximum productivity, whether working alone or as part of a team effort.

The major objective of the Tektronix Design Automation Division is to produce and support this new generation of digital design tools, elevating the efforts of individual engineers to the creative or conceptual level, where they can operate in a truly cost-effective manner. The goals of the Design Automation Division are enhanced by Tektronix' special position in the digital electronics industry.

On the one hand, Tektronix is a designer and producer of microcomputer-based equipment, and directly experiences all the challenges inherent in the digital design process. On the other, Tektronix has long been a supplier of superior instrumentation supporting all phases of electronic design. This dual role provides an ideal creative climate for the engineers in Design Automation Division to conceptualize and develop design tools that both reflect an immediate involvement with the tool's end use and help to sustain our traditional commitment to excellence in product.

Currently, the Design Automation Division's products fall into three major categories: Microcomputer Development Systems, Logic Analyzers and Semiconductor Test Systems. In addition to the dedicated functions performed by each, powerful synergistic combinations are being developed which will provide designers with the types of hybrid tools that will be necessary in the very near future.

The Division's 8500 Series Microcomputer Development Systems provide total support for microcomputer-based software development and hardware/software integration. Through a modular architecture, these systems supply "universal" support, allowing the designer to choose from a wide variety of chip families for a particular design. The 8500 Series provides extensive software support, including compilers, assemblers, and many special software tools that automate much of the code development and integration process. At the multi-user level, this support includes a powerful TNIX* operating system, derived from Bell Lab's UNIX** operating system, that permits intense interaction between team members working toward a common program goal.

The Division's Logic Analyzer products cover the spectrum of digital applications, from on-site servicing to the design of large mainframe computer systems. In all cases, product focus development has been to provide ease-of-use, combined with state-of-the-art performance. The new Color DAS Digital Analysis System, for example, brings a color CRT display to logic analyzers for the first time and also provides the fastest data acquisition speeds available. Another example is the 7D02 Logic Analyzer, a product dedicated to microcomputer-based design through a series of personality modules that automatically adapt it to the processor under test. Yet another is the portable 308 Data Analyzer, which operates in serial and signature modes as well as parallel state and timing modes.

Design Automation Division's S-3200 Series of Semiconductor Test Systems provides a complete, integrated circuit-testing environment that gives an engineer total control over all test procedures. Through a single interface, the user can easily write evaluation and characterization programs, run the tests, and format test results into quickly readable graphic or tablular displays. At the same time, upward compatibility guarantees the integrity of test software when transported to different systems within the S-3200 Series. Through advanced hardware, tests can be run on even very complex devices, including hybrids such as codecs. Specialized test devices, like memory pattern generators and waveform digitizers, permit the system to test almost any type of IC available.

To support its growing product line, the Design Automation Division has assembled a staff of technical personnel who are intimately familiar with the needs of the design engineer. From sales to applications assistance to service, you get the kind of backup that today's sophisticated design tools demand. In addition, the Division maintains a comprehensive education/training program, including workshops and seminars on all phases of microcomputer-based design.

The Design Automation Division has made a firm commitment to provide design tools built to accommodate the future. As evidence, many DAD products have modular architecture that allows the inclusion of high-performance modules as they become available. Also, many software products can migrate from one system to another as the user's hardware base is upgraded. Through techniques such as these, the Design Automation Division will continue to support the design engineer, who faces a digital world full of challenge and promise.

** TNIX is a trademark of Tektronix*
*** UNIX is a trademark of Bell Laboratories*

MICROCOMPUTER DEVELOPMENT PRODUCTS

CONTENTS

Microcomputer Development Labs
Microcomputer Development Cycle 46
COLORKEY+ 49
Editors 50
Compilers 51
High-Level Debug 53
Emulation 54
Software Development System 57

MDL Now Supports

8088/87	*68000*	*Z80A*
8086/87	*68120/121*	*Z80B*
8085A	*6800*	*Z8001*
8080A	*6801*	*Z8002*
8048	*6802*	*TMS9900*
8049	*6803*	*SBP9900*
8035	*6808*	*SBP9989*
8039	*6809*	*1802*
8021	*6809E*	
8022	*68008*	
8041A	*68010*	

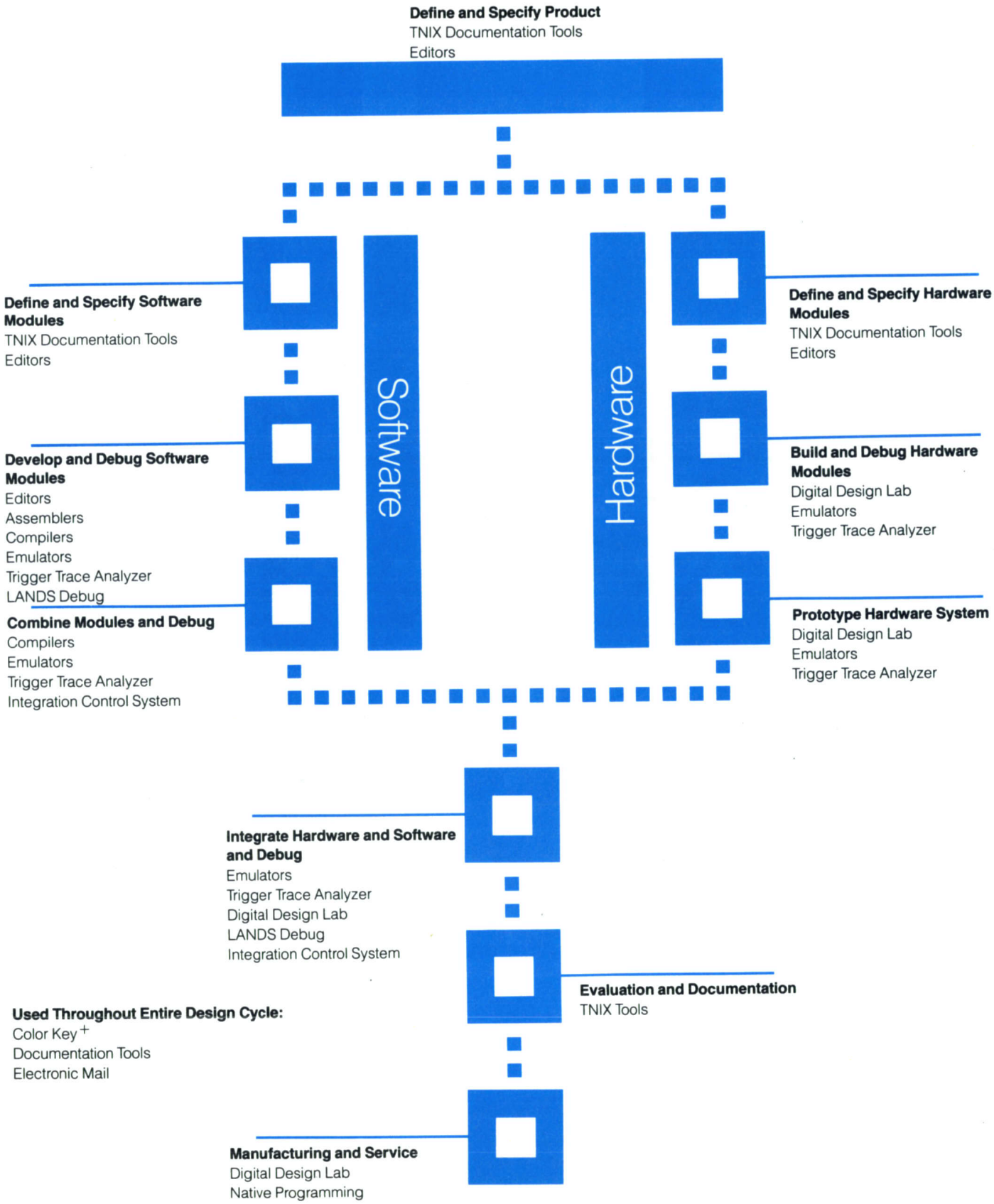
MDL Future Support

80186	*F9450/*	*7809*
80286	*1750A*	*78C06*
	NSC800	*7720*
		7811

Tektronix Microcomputer Development Products offer the broadest range of quality multiple microprocessor support available today. Tektronix won't lock you into one microprocessor family or vendor. Plus, every Tektronix MDL is backed with over 30 years experience in meeting designer's needs. We test our Development Labs thoroughly to ensure performance and reliability. Each one provides complete development capability and the Tektronix commitment that guarantees you'll keep abreast of the fast paced microprocessor technology.

Call your local specialist today to find out more about Tektronix MDL Systems.

Microcomputer Development Cycle



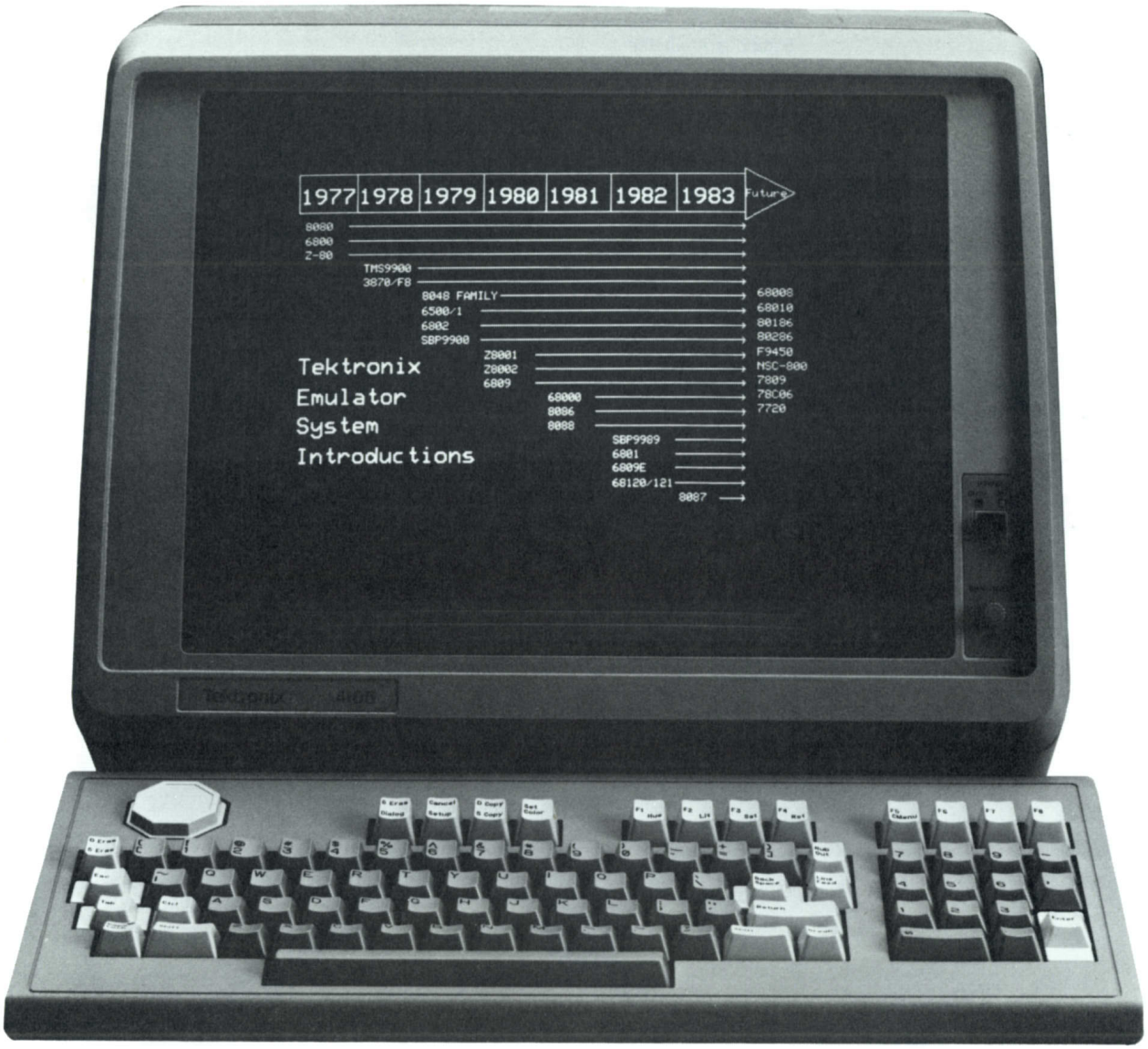
Tek Tools Help you be More Productive Throughout the Entire Microcomputer Design cycle.

Over time, microcomputer designers have developed a systematic microcomputer design cycle which guides a microprocessor-based product from concept and definition through to manufacture and service. Each step in the cycle presents a unique set of problems and challenges to the engineer. Also, each step is critical to building a successful product.

Every phase in the cycle presents you with different demands. These demands are growing more complex as microcomputer hardware moves from the 8-bit to the 16-bit level and beyond. The only practical solution is more powerful design tools.

Tek's 8500 Series Automates The Design Cycle.
Only the Tektronix 8500 Series can give you design support broad enough to embrace the entire design cycle. No matter where you are in the cycle, Tektronix has design automation tools that dramatically increase the effectiveness of the engineer in developing a better product in less time and at a substantially lower cost.

Tek's 8500 Series design tools cover more design cycle tasks with greater effectiveness than any other engineering tool set on the market today. And they do so with a level of quality that has made Tektronix the leader in digital design instrumentation.



NEW

MICROCOMPUTER DEVELOPMENT

Tek Microcomputer Development Systems Expand with Your Needs.

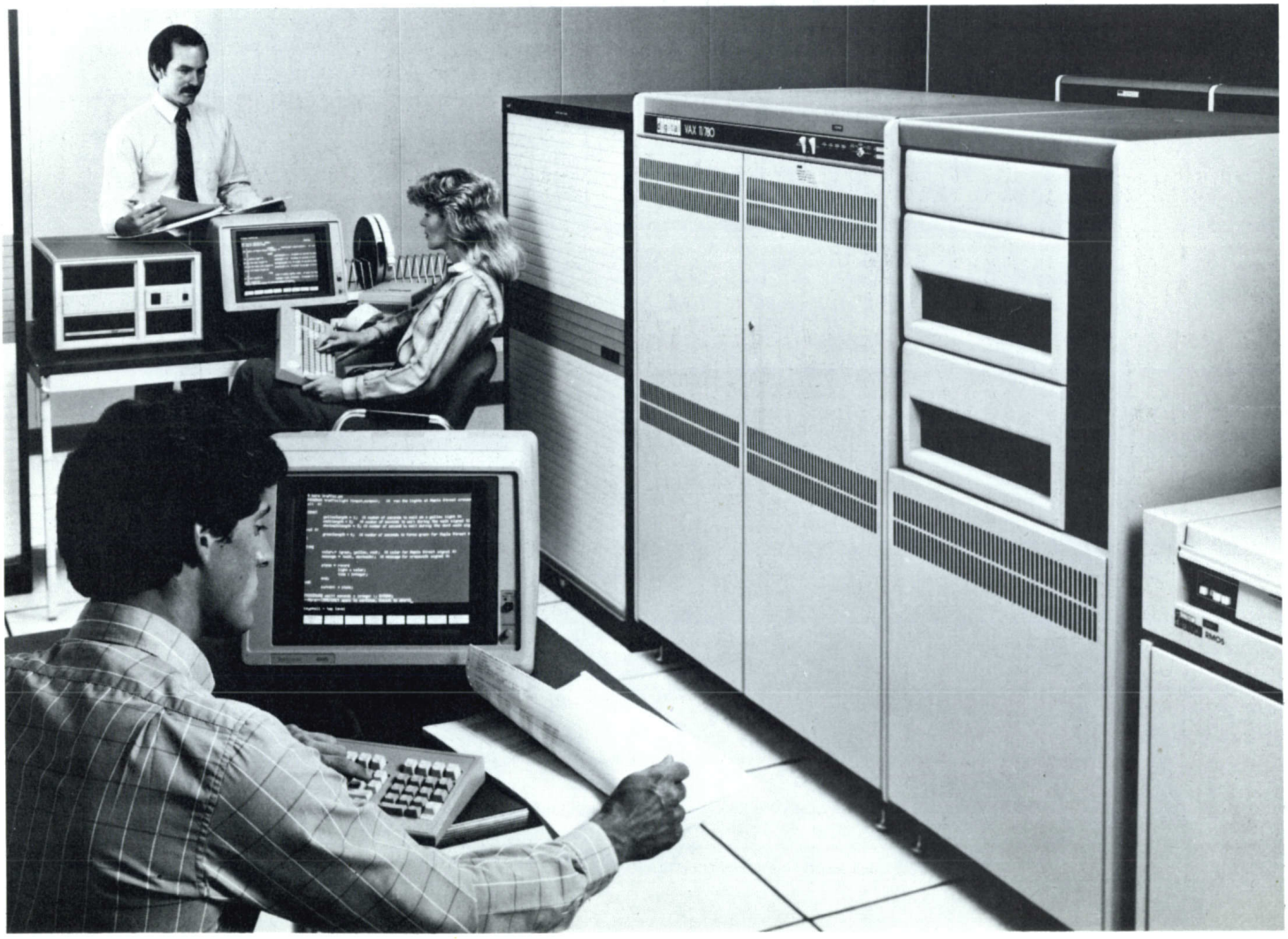
No matter what the size and scope of your engineering operations, Tek provides a solid hardware foundation for your microcomputer design tool set.

For entry-level operations, the 8561 Software Development Unit provides a complete, cost-effective computer system that's expandable from one or two users or up to eight users. For more advanced environments, the 8560 Software Development Unit starts with four users and expands to eight workstations. Both systems will accommodate up to 1 Mb of RAM and 140 Mb of hard disc storage to support large, sophisticated design environments.

For either system, emulation and debug functions are supplied by the 8540 Integration Unit, which offers the widest and best emulation support available today. The 8540's modular architecture accepts Tektronix real-time emulation modules for a wide range of 8-bit and 16-bit microprocessors.

Tek Software Compatibility.
Tek also offers powerful High Level Language tools and many popular assemblers on Digital Equipment Corporation's VAX Series of computers using either the VMS or UNIX 4.1 bsd operating systems. This Tek/DEC combination gives you a powerful series of options when configuring your design environment. You can run Tek software development tools on the VAX to produce executable object code, and easily download the code to a Tek 8540 Integration Unit to perform emulation/debug tasks. Tek supplies you with the software needed to make your VAX/8540 combination function as a turn key system. In more advanced configurations, you can interface entire 8560/8540 systems to the VAX to create a powerful distributed processing system with the VAX acting as the central manager.

Regardless if you start with the entry level 8561 or a VAX 780, the Tek software tools will allow you to transport the programs you generate from one computer to another.



NEW

MICROCOMPUTER DEVELOPMENT

Single Key Interactive COLOR Interface to Tek Design Tools

COLORKEY+ and the Tek 4105M color graphics terminal combine to give you simple, single key stroke access to the powerful set of Tek microcomputer design tools. The color scheme has been selected to maximize the readability of complex information and to reduce user fatigue. The color coding and graphically defined "soft" keys guide you through the system with a minimum of effort or knowledge.

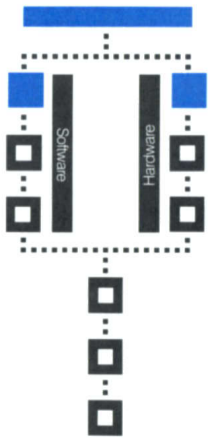
While COLORKEY+ gives pushbutton access to various tools and greatly accelerates the user learning curve for the system, it does not constrain the more advanced user. At any time, you can directly enter commands to the Tek microcomputer design tools.

Design Documentation and Team Communications Support
At the product definition stage of the design cycle and at many stages thereafter, good communications and timely, accurate documentation are essential. Tek's TNIX operating system and its related utilities cover both these requirements. For team communications, electronic mail, intersystem communications and file linking are available. For documentation, TNIX offers a powerful text processing package that allows fast, simple document generation and updating.

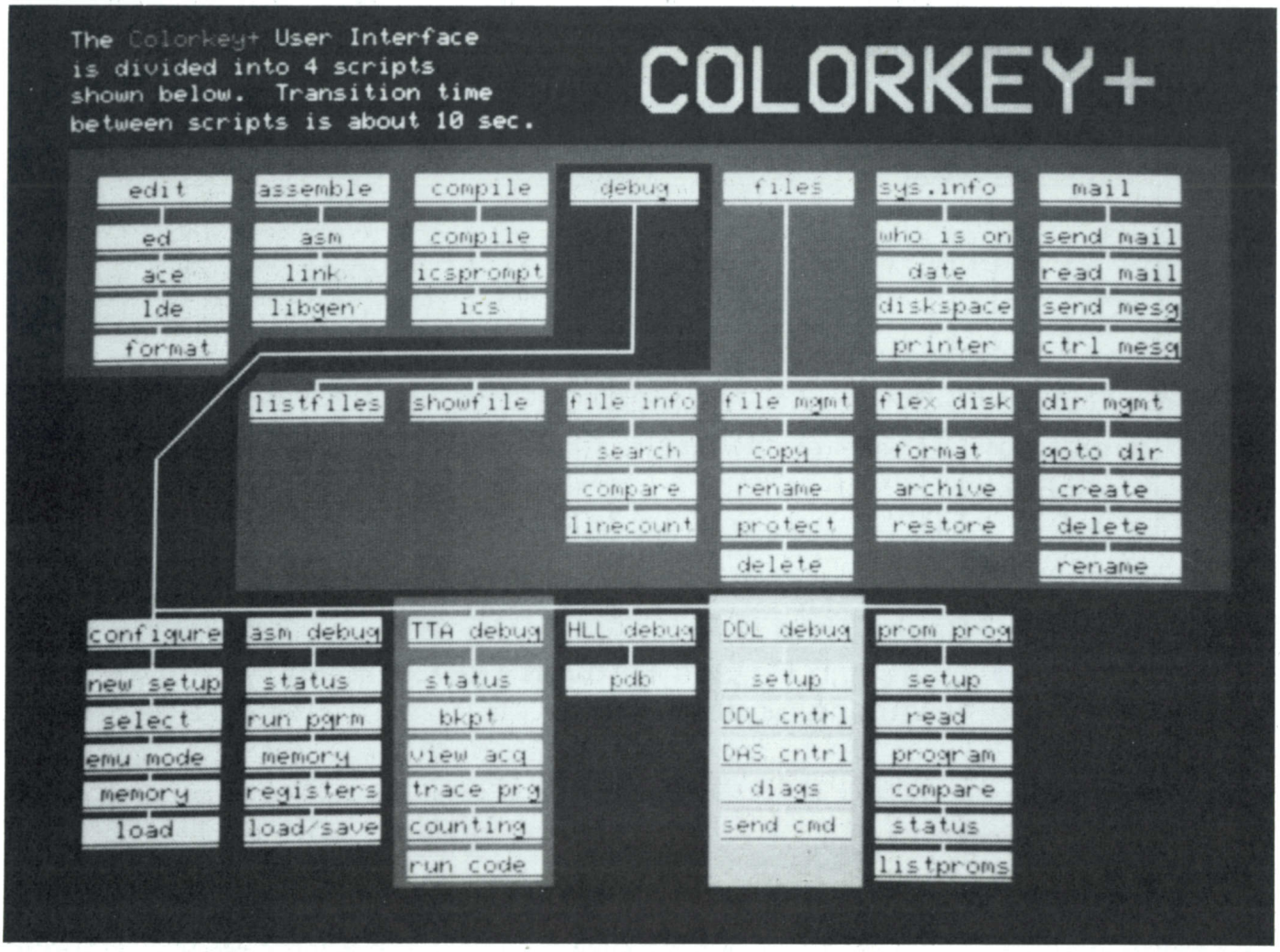
Define and Specify Product
TNIX Documentation Tools
Editors

Define and Specify Software Modules
TNIX Documentation Tools
Editors

Define and Specify Hardware Modules
TNIX Documentation Tools
Editors



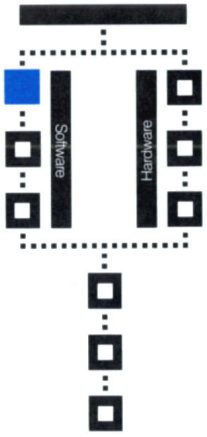
COLORKEY+ User Interface



Tek Editors Expedite Code and Text Entry

Define and Specify Software Modules

TNIX Documentation Tools
Editors



During software development and document preparation, high performance editors become critical tools in the design effort. Different tasks within the design cycle can be made more productive by using an editor specifically designed for the task. Also individual users have different preferences as to the type of editor they like to use. Tek offers a selection of editors to handle the different tasks and individual preferences.

General Purpose Editors

The TNIX line editor, "ed", lets you make sweeping changes in your code or documentation with a minimum of effort. With the streamlined command set of "ed", updates are easily accomplished.

The Tek Advanced Screen-Oriented Editor (ACE) is an ideal choice for text entry and cursor-directed screen editing at specific locations within your code or text.

High-Level Source Code Editors

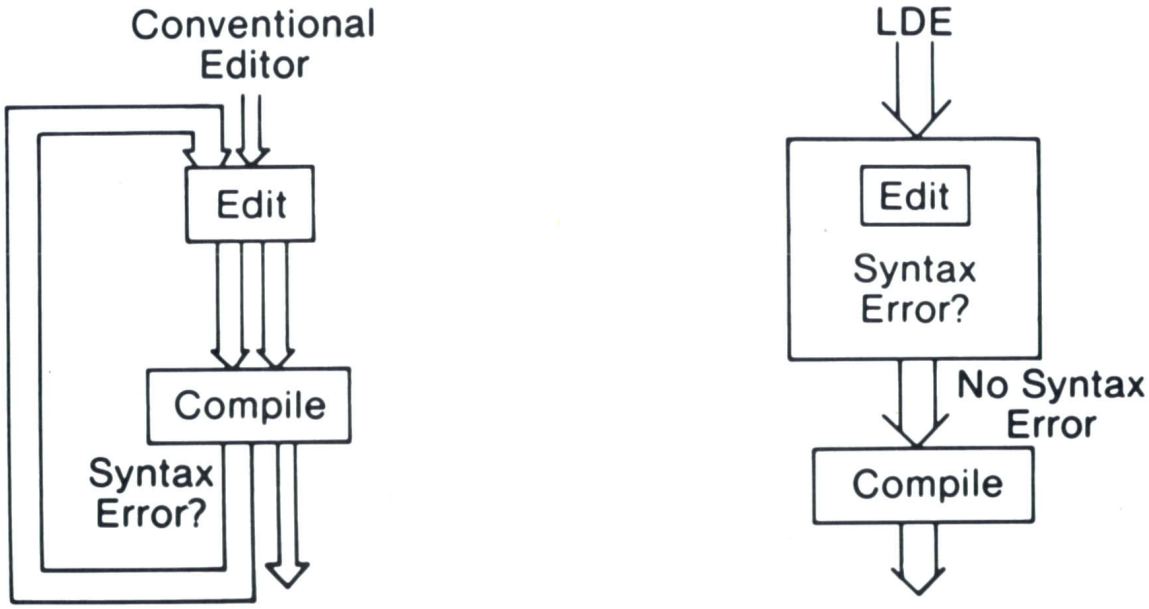
Tek's LDE (Language-Directed Editor) is an integral part of the Tek LANDS (LANguage-oriented Development System). LANDS allows editing, compiling, integrating, and debugging a program in the same high level for the entire cycle. The LANDS package consists of LDE for PASCAL, or "C" Compiler, Integration Control System and Debug, thus allowing the user to work through the S/W design and debug cycle while remaining at a high level.

LDE is actually able to understand the syntax of the source code you have entered and flag any syntax errors while you are still in the editor. LDE's syntax error detection eliminates the need to run lengthy compilations just to locate syntax errors, LDE is also an excellent general purpose screen-oriented editor.

Special Editing Tools

The TNIX Auxiliary Utilities Package contains several specialized tools that allows sweeping changes to multiple files automatically. For example, if you have several assembler source files and you wish to change all the assembler directives, you could use these tools to accomplish this task automatically.

TEK GIVES YOU THE CHOICE OF EDITOR THAT WILL BEST ACCOMPLISH THE TASK YOU WISH TO PERFORM.



LDE Saves Time

- Reducing Passes Through The Compiler
- Reducing Coding Errors

Tek Compilers and Assemblers

Microcomputer software design demands a highly sophisticated set of programming tools that maintain high productivity while permitting logic manipulations all the way down to the hardware level. In response, Tek compilers and assemblers bring you an advanced feature set that streamlines your coding effort while retaining the power you need to implement machine-level operations.

High-Level Amenities for Assembly Coding
With Tektronix assembler/linkers, you get many features that are normally only associated with high-level coding. You can create sophisticated macro statements that provide high-level coding power.

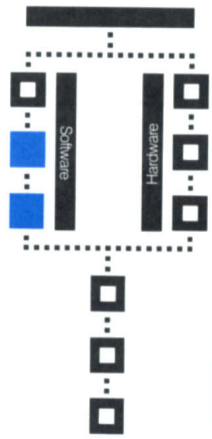
The INCLUDE directive can be used to include other files containing assembler source, date types, constants and variables. Conditionals, using Boolean expressions, are available to help you control the assembly process. In addition, Tek assemblers all share the same base, which means once you learn a Tek assembler you can move from one microprocessor to another with a minimum of learning time. All the MACRO commands, expression handling and assembler directives are the same.

Tek Compilers Offer More Than Generation of Quality Code.
For high-level language programming, Tek's PASCAL and "C" compilers give you all the established benefits of structured languages plus the ability to do operations such as interrupt handling, I/O port access and bit manipulation without ever having to resort to assembly language code.

To insure compatibility for porting existing programs, Tek's PASCAL-Compiler adheres to the ISO standard and Tek's "C" Compiler adheres to Kernighan and Ritchie's standard.

Develop and Debug Software Modules
Editors
Assemblers
Compilers
Emulators
Trigger Trace Analyzer
LANDS Debug

Combine Modules and Debug
Compilers
Emulators
Trigger Trace Analyzer
Integration Control System



CONDITIONALS

IF ELSEIF ELSE ENDIF

IF Type = "US"

U S Code

ELSEIF Type = "European"

European Code

ELSE

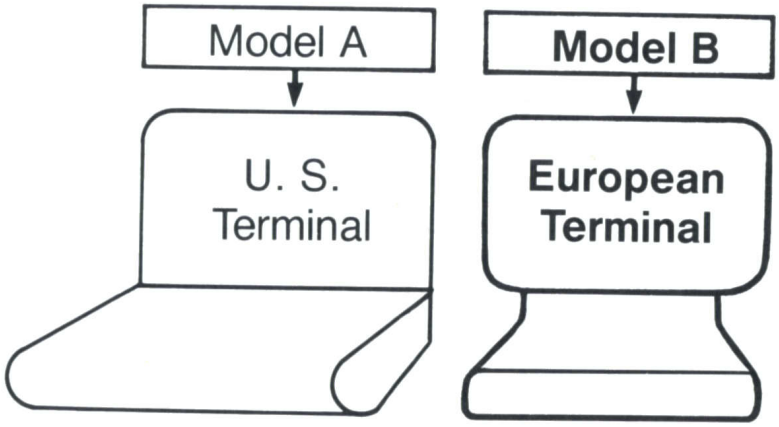
Warning No Model Selected

ENDIF

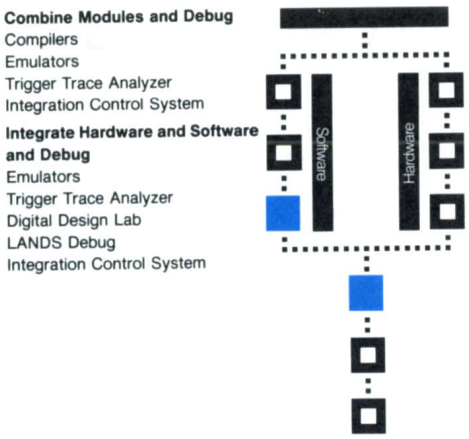
CONDITIONALS

Inline Or In Macros

Program



LANDS Automates Hardware/Software Interface Definition with ICS



One major task associated with microcomputer design is to correctly interface the software with the specifics of the prototype hardware. When the software has been generated in a high-level language like PASCAL or "C", this task can become quite complex and time consuming. However, with Tek's Integration Control System (which is a standard part of Tek's compilers) the hardware/software interface definition is almost entirely automated.

Linker Command File Automatically Generated

To use ICS, all you have to do is answer questions from the ICS prompter about your software and hardware prototype. ICS does the rest. First, it creates a linker command file which adheres to the memory parameters you've specified. Constants, instructions and global variables are all automatically assigned to their correct locations within the prototype address space.

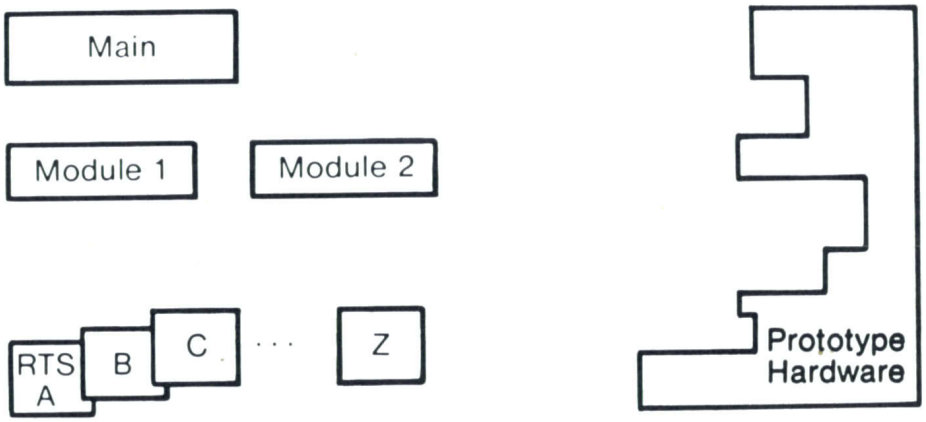
Reset and Interrupt Handler Code Supplied

ICS generates any code needed to link low-level interrupt vectors to your service routines. It also generates the object code needed to handle the initialization/reset operation. Normally, interrupt and initialization/reset code would have to be manually programmed in assembly language and then linked with the high-level code.

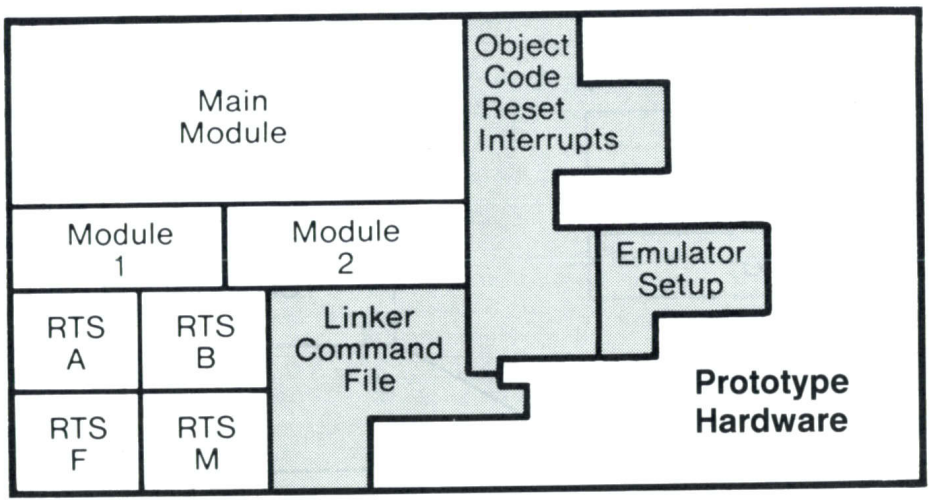
ICS Creates Emulator Command File

In addition to automating the hardware/software interface task, ICS also creates an emulator command file which allows you to download the linked object and execute it in a single command. You save both time and effort in the debug stage of the design cycle.

The Integration Puzzle



ICS Brings it Together



LANDS High-Level Debug Pulls Debug Operations Up To The Source Code Level

With most development systems, any trace information accumulated by the debug software is displayed in an assembly code format. Unfortunately, this code bears little or no resemblance to the original PASCAL or "C" source code. A great deal of time and effort is spent figuring out the relationship between assembly-level debug information and the original source code.

Tek's LANguage-oriented Development System solves this long-standing problem through High-Level Debug, which translates debug information back into its counterparts at the PASCAL or "C" source code level.

Track Real-Time Execution Bugs in Source Code

With High-Level Debug, all your debug commands can be entered using source code terminology. In PASCAL, breakpoints can be assigned using compiler-assigned statement numbers. Program execution can also be halted using specific procedure or variable names. Values can be returned to calling functions.

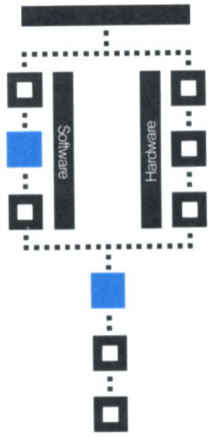
You can even single-step through your high level language program statement by statement or reset the program to its original starting point.

Powerful Debug Display Features

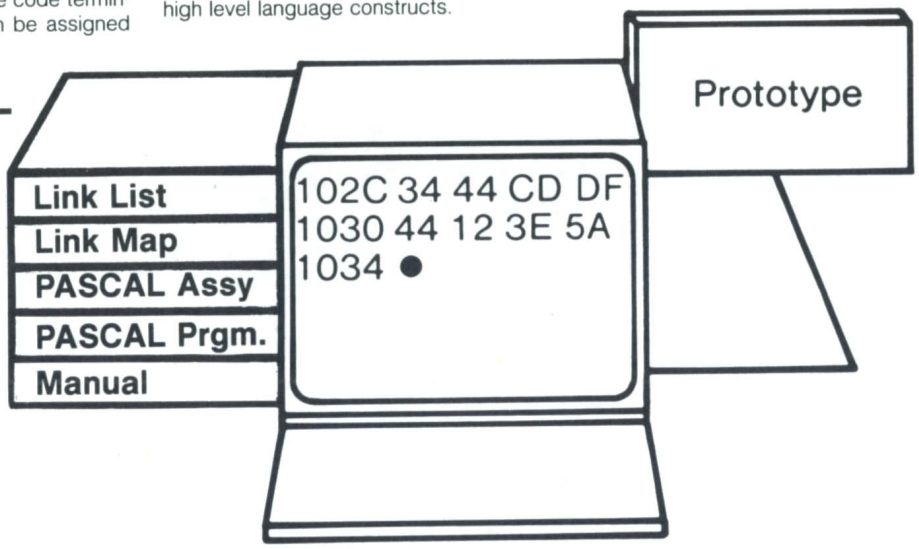
High-level Debug also gives you the capability of displaying your program in high level source form, thus speeding the analysis. For instance, in PASCAL, you can trace procedure calls and obtain a listing of each time the procedure is entered or exited and the value of any parameters. Also, variables can be displayed, modified and evaluated in their original source code terms. There is no need for the time-consuming task of translating hexadecimal responses to the corresponding high level language constructs.

Develop and Debug Sofware Modules
Editors
Assemblers
Compilers
Emulators
Trigger Trace Analyzer
LANDS Debug

Integrate Hardware and Software and Debug
Emulators
Trigger Trace Analyzer
Digital Design Lab
LANDS Debug
Integration Control System

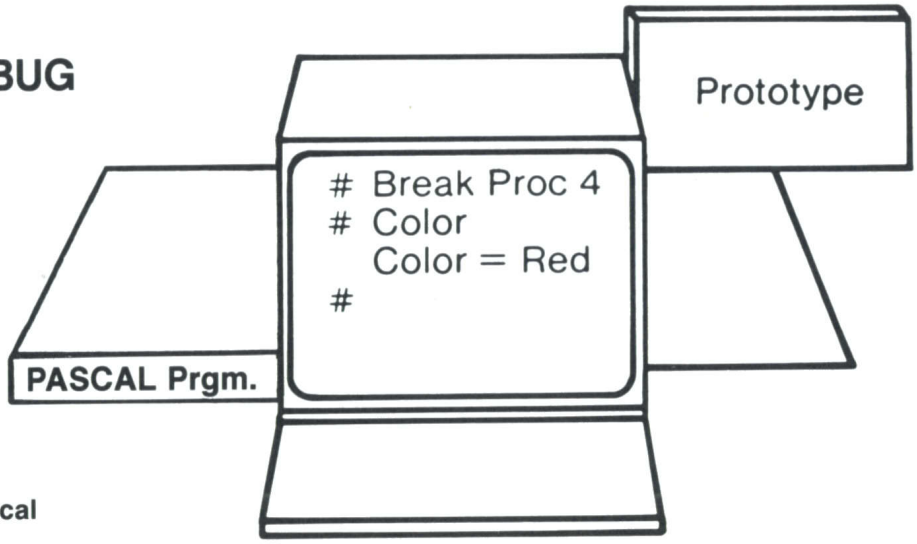


CONVENTIONAL



User Needs Heavy Documentation To Translate From Hex to Pascal

PASCAL DEBUG



User Debugs in Pascal

Emulators and Trigger Trace Analyzer

Provide powerful insights into the interaction of software and hardware execution with emulators and trigger trace analyzer.

Emulation is well accepted as the most effective method of debug during hardware/software integration, and Tektronix is largely responsible for establishing it. Since 1977, when Tek introduced its 8080, 6800 and Z-80 emulators, the company has been the undisputed leader in supplying the microcomputer engineering community with superior emulation systems. In recent years, this leadership position has been enhanced by advances such as real-time emulation with no wait states and support for 16-bit processors, such as the Motorola 68000 and the Intel 8086 Series.

Real-Time Emulation

Real-time emulation is accomplished by executing code on a processor identical in function to the one targeted for the prototype hardware. The emulator processor is run under the control of powerful debug software that allows control and tracing of the code's execution. This debug software does not need to be linked into your code or use any of your memory or interrupt lines.

Tek's superior emulators allow your code to execute in real-time, with no wait states inserted or clock pulses stretched. This means the emulator is fully transparent to the user; therefore you do not spend time "working around" the development system.

Trigger Trace Analyzer Captures Real-Time Events

A powerful option to Tek emulators is the Trigger Trace Analyzer, which uses a high-speed buffer to capture real-time software and hardware logic events, with the prototype running at the design's full specified operating speed. Multiple word recognizers allow you to define sophisticated triggers when tracing code execution. And data qualification allows you to capture only the data you wish to see.

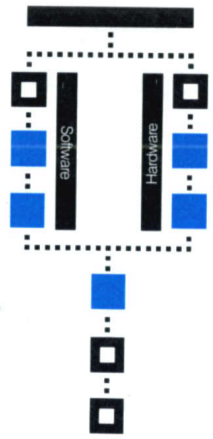
Develop and Debug Software Modules
Editors
Assemblers
Compilers
Emulators
Trigger Trace Analyzer
LANDS Debug

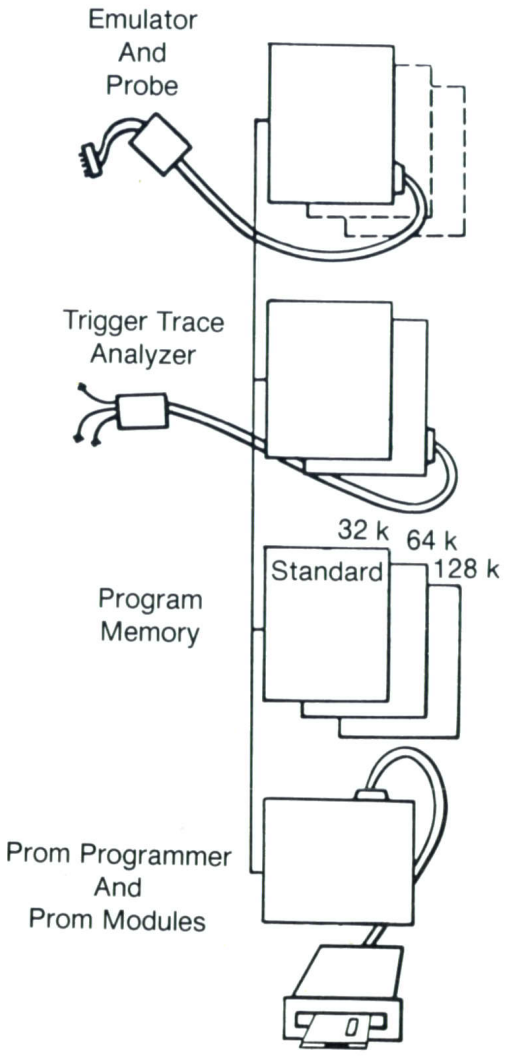
Combine Modules and Debug
Compilers
Emulators
Trigger Trace Analyzer
Integration Control System

Integrate Hardware and Software and Debug
Emulators
Trigger Trace Analyzer
Digital Design Lab
LANDS Debug
Integration Control System

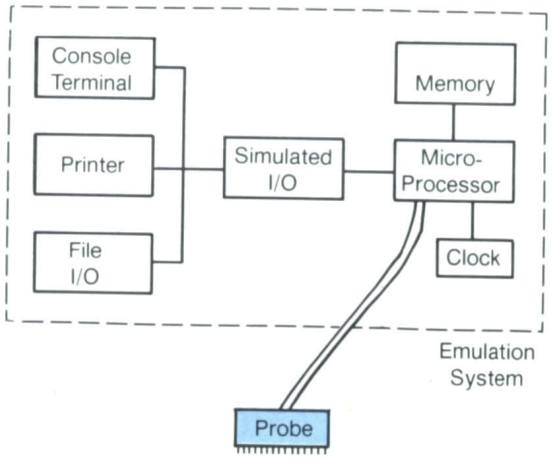
Build and Debug Hardware Modules
Digital Design Lab
Emulators
Trigger Trace Analyzer

Prototype Hardware System
Digital Design Lab
Emulators
Trigger Trace Analyzer



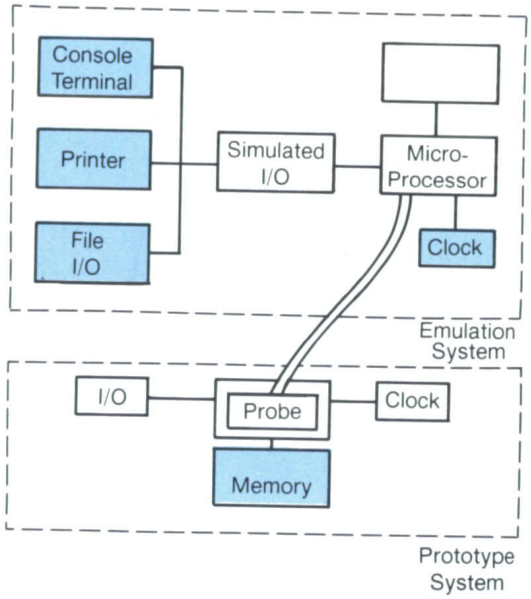


FULL FEATURE
Phased Emulation—Mode 0



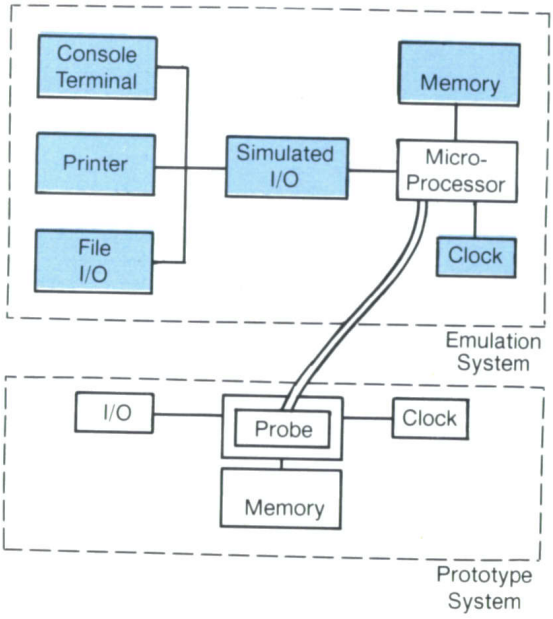
- Software Tested On Actual Microprocessor
- No Prototype Hardware Required
- Prototype I/O Interactions Are Simulated
- All Emulator Debug Functions Are Available

FULL FEATURE
Phased Emulation—Mode 1



- Prototype Software & Hardware Tested Together
  - —All Clock, I/O & Interrupts Tested
  - —Real-Time Environment
- Memory Substitution
  - —No PROMs To Program
  - —Can Debug Without Working Memory System
- Program Is Transferred To Prototype In Steps
- All Emulator Features Available

FULL FEATURE
Phased Emulation—Mode 2



- Final Test Of Hardware & Software
- All Prototype Memory Tested
  - —PROM, ROM, Etc.
  - —Dynamic Or Static RAM
- All Emulator Features Available

NEW

MICROCOMPUTER DEVELOPMENT

Simultaneous Debugging of Multiple Processors

A greater number of microcomputer designs now involve either dual processors or a single processor closely coupled to other intelligent hardware within the prototype. Tek meets the challenge of these designs through the Digital Design Lab, which combines the power of the Tektronix 8560/8540 Microcomputer Development System with the Tektronix DAS 9100 Digital Analysis System.

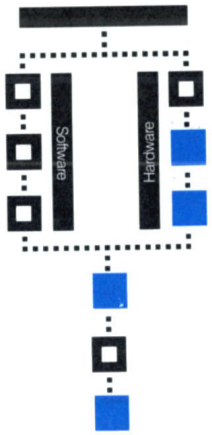
Through a single terminal interface, the user has complete control of both systems. An 8540 emulator traces one processor's execution while the DAS 9100 traces the second intelligent chip. The real-time data flow from these two sources is time stamped as it is stored in memory. The data can then be formatted in a time-synchronized manner for display and analysis. This time correlation capability allows you to see the cause and effect relationships between the two circuit elements being debugged. The result is a powerful insight into separate, but related data flows within the same prototype system.

Integrate Hardware and Software and Debug
Emulators
Trigger Trace Analyzer
Digital Design Lab
LANDS Debug
Integration Control System

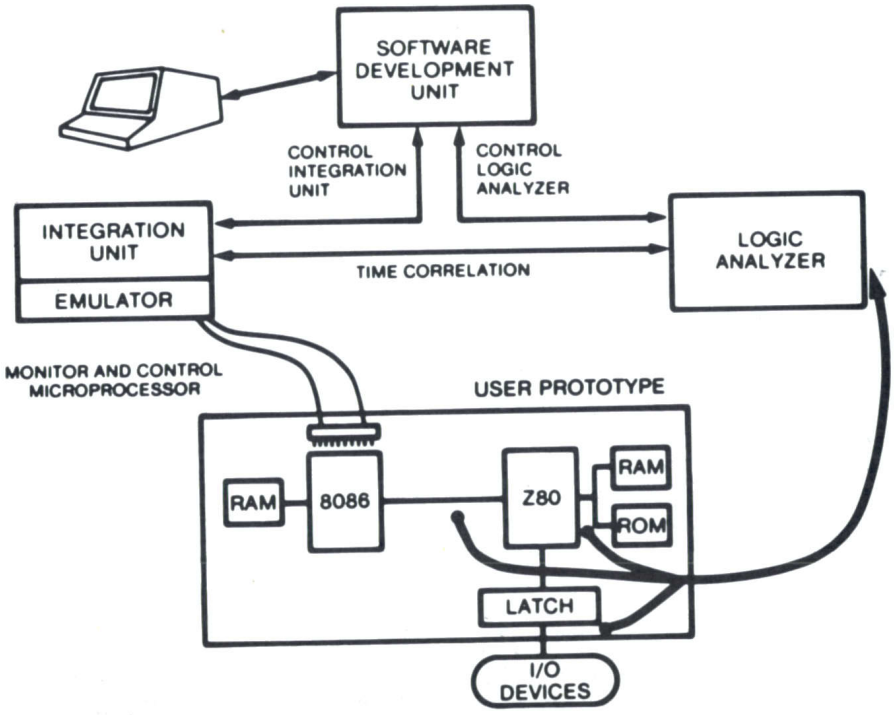
Manufacturing and Service
Digital Design Lab
Native Programming

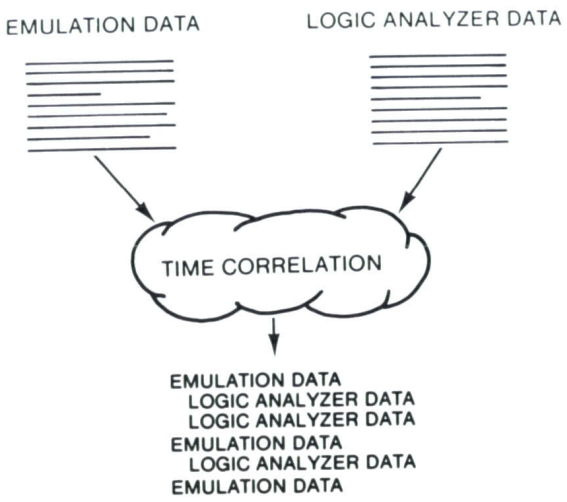
Build and Debug Hardware Modules
Digital Design Lab
Emulators
Trigger Trace Analyzer

Prototype Hardware System
Digital Design Lab
Emulators
Trigger Trace Analyzer



THE SOLUTION: TIME CORRELATION





8561

Multi-User Software Development Unit

Powerful, Low-Cost Entry-Level Microcomputer Development System Supporting One or Two Users with 13.6 Megabyte Disk Storage, 1 Mb floppy and 265 kilobytes of RAM Memory

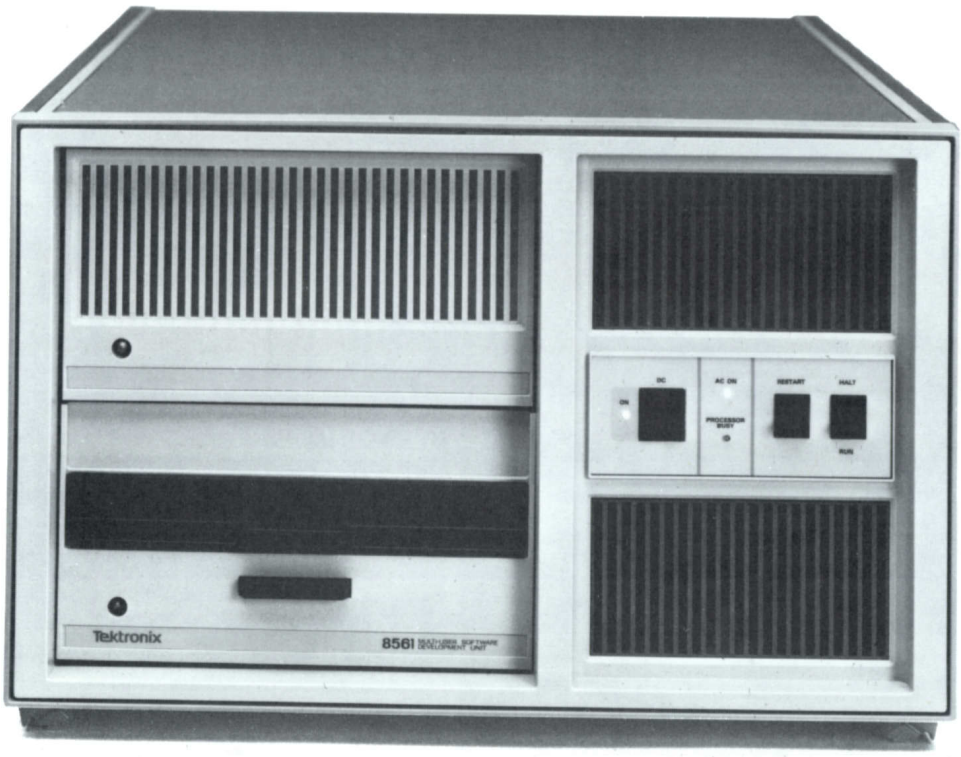
Easily Expanded Into a Full Tektronix 8560 Development System Supporting Up To Eight Users, 35.6 Mb Disk Storage and 1 Mb Memory

Full Software Design and Integration Support For Over Twenty 8-Bit and 16-Bit Microprocessors

TNIX Operating System Based On The Powerful, Widely Accepted UNIX Operating System from Bell Laboratories

Large Selection of Software Design Tools, Including Full PASCAL Support for most 16-Bit Processors That Covers The Entire Design Cycle from Source Code Entry to Debug Operations.

Complete Compatibility With Tektronix 8540 Integration Unit for Hardware/Software Integration Through Real-Time Emulation



The Tektronix 8561 Software Development Unit provides a powerful and complete set of microcomputer design tools to the smaller design team while accommodating future expansion through a simple, cost-effective upgrade path. The basic 8561 fully supports two workstations, which may be either standard CRT terminals or Tektronix 8540 Integration Units designed specifically to handle hardware/software integration tasks through real-time emulation. Through a series of upgrade options, this basic package can be expanded to accommodate up to eight workstations.

The basic version of the 8561 includes an LSI 11/23 16-bit processor, 256 kb of RAM, 13.6 Mb hard disk storage, 1 Mb of flexible disk storage, 2 user ports and 2 line-printer ports. This basic system can be easily upgraded within the same mainframe to up to 8 user ports and 35.6 Mb of hard disk storage and 1 Mb of main memory.

All versions of the 8561 run under TNIX, an exceptionally powerful operating system derived by Tektronix from Bell Laboratories' UNIX. TNIX is dedicated specifically to supporting the microcomputer design process. The 8561 can fully utilize a wide range of Tektronix microcomputer software design tools covering over 20 8-bit and 16-bit microprocessors. These include compilers, assemblers, editors and text processors plus the symbolic debug tools and high-level debug tools used in conjunction with the 8540 Integration Unit.

CHIP SUPPORT	8561			8540		
	PASCAL	LANDS	Assembler	Emulator	Probe	TTA
68000/008/010	X	X	X	X	X	X
8086/8088/186	X	X	X	X	X	X
Z8001/Z8002	X	X	X	X	X	X
9900/9989			X	X	X	X
Z80B			X	X	X	X
6809/6809E			X	X	X	X
68120			X	X	X	X
6801			X	X	X	X
8048 family			X	X	X	X
8051			X			
8080/8085			X	X	X	X
1802			X	X	X	X
6800/6802			X	X	X	X
Future Chip Support:						
NSC800						
7720						
7809						
7811						
78C06						
80286						
1750A						
F9450						

System Expansion

Better Utilization of Existing Equipment

Additional 21 Megabytes of Disk Space for User Programs

Common Files Easily Shared

All Software Transported Intact

Upgrading The 8561

Your 8561 was designed to be easily and quickly upgraded to four users and 35.6 Mb hard disk. All software you have written, directory formats, passwords, etc., can be ported to your upgraded system.

Utilization of Existing Equipment

By upgrading your 8561, you add two (or six) more valuable user ports which can take advantage of the equipment and software you already have.

More Disk Space

Your 8561 comes standard with a 13.6 Mb disk. After formatting and installing the TNIX operating system, approximately 9.1 Mb of disk space is available.

Here are some approximate numbers you can use to determine how much disk space is available for user programs:

Assembler	0.11 Mbytes
Compiler	0.46 Mbytes
Language Directed Editor	0.18 Mbytes
HLL Debug	0.11 Mbytes
Advanced Screen Editor	0.07 Mbytes
Auxiliary Utilities Pkg	1.10 Mbytes
Text Processing Pkg	0.75 Mbytes
Native Programming Pkg	0.64 Mbytes

As an example, assume a system with an assembler, compiler, LDE, HLL debug, auxiliary utilities package and text processing package. These packages require 1.7 Mb of disk space. The total disk space available for user programs is 6.4 Mb or 3.2 Mb/user with two users.

After upgrading you will gain an additional 21 Mb of disk space or a total of 27.4 Mb, 6.85 Mb/user with four users.

In addition, an upgraded system is compatible with the Tektronix 8503 35 Mb Disk Expansion Unit. Three 8503's can be added to your upgraded 8561.

Share Common User S/W Easily

After upgrading, you now have four users who can share user-generated programs and also be assured of the latest versions.

Quick and Easy Upgrades

Your upgrade can be performed at your local Tek service center. The 8561F08 gives you an additional 22 Mb of hard disc and two extra user ports. The 8561F09 adds six extra user ports, as well as the extra 22 Mb of hard disc.

Performance

The 8561 comes standard with 256 k of system memory. Depending on how much software work you plan to do, you may wish to add system memory. Added system memory will help to maintain the speed of the system should heavy demands be placed on the system processor.

TNIX Operating System
The 8561 Multi-User Software Development Unit's TNIX operating system is ideally suited to the team-oriented microcomputer software design environment and contains many features targeted specifically at improving the productivity of individual engineers participating in a collective design effort.

TNIX gives an important boost to user productivity through multitasking, which allows a user to run several tasks simultaneously. For instance, one source code file could be assembled or compiled while another was being edited. Further, different tasks can be arranged in descending levels of priority to make best use of the system's capabilities. Also, line printer spooling can be invoked.

TNIX utilizes a powerful hierarchical filing system which gives you fast access while promoting superior file organization of the team level. Files are arranged in a "tree" structure with as many hierarchical levels as your design needs require. Each level accommodates either files or directories pointing to more files or directories at lower levels.

In addition, TNIX provides exceptionally flexible read and write protection, so software can be progressively released to wider group of users as it becomes more fully debugged. There are also provisions for easy file sharing and electronic mail between system users.

To streamline interaction with the 8561 system, TNIX permits the construction of command files which minimize typing and execution of repetitive tasks. These files permit simple command execution sequences, and also the inclusion of high-level control structures such as FOR loops, CASE statements, IF-THEN-ELSE statements, and WHILE and UNTIL loops. TNIX also permits "pipelining", which connects the standard output of one program to the standard input of another. For instance, a single, pipelined command could list file names from a directory, paginate them into a two-column format and then queue the result for printing.

To simplify the debugging of large programs composed of many modules, TNIX features a tool called "make", which ensures that all interdependent source code modules have been reassembled to reflect updates entered after debugging. "Make" removes build errors and eliminates a great deal of recompiling by regenerating only those files which need it before being linked into the latest version of the executable object code.

Documentation is a major requirement of almost any microcomputer software development project, and TNIX provides special support for this need through an optional documentation package. This package includes a diverse set of word processing and report generation functions which enable users to quickly complete all their documentation tasks without ever leaving the 8561 system environment.

Microprocessor Design Support
The 8561 gives you complete access to all of Tektronix' software development and integration tools, which support over twenty of the most commonly used 8-bit and 16-bit microprocessors.

This includes advanced high-level support such as LANDS, PASCAL, the first PASCAL microcomputer software development package that supports all phases of the design cycle. At the source stage, LANDS includes a Language-Directed Editor which understands PASCAL syntax and flags all syntax errors before they reach the compiler, thus eliminating a major cause of the need to recompile.

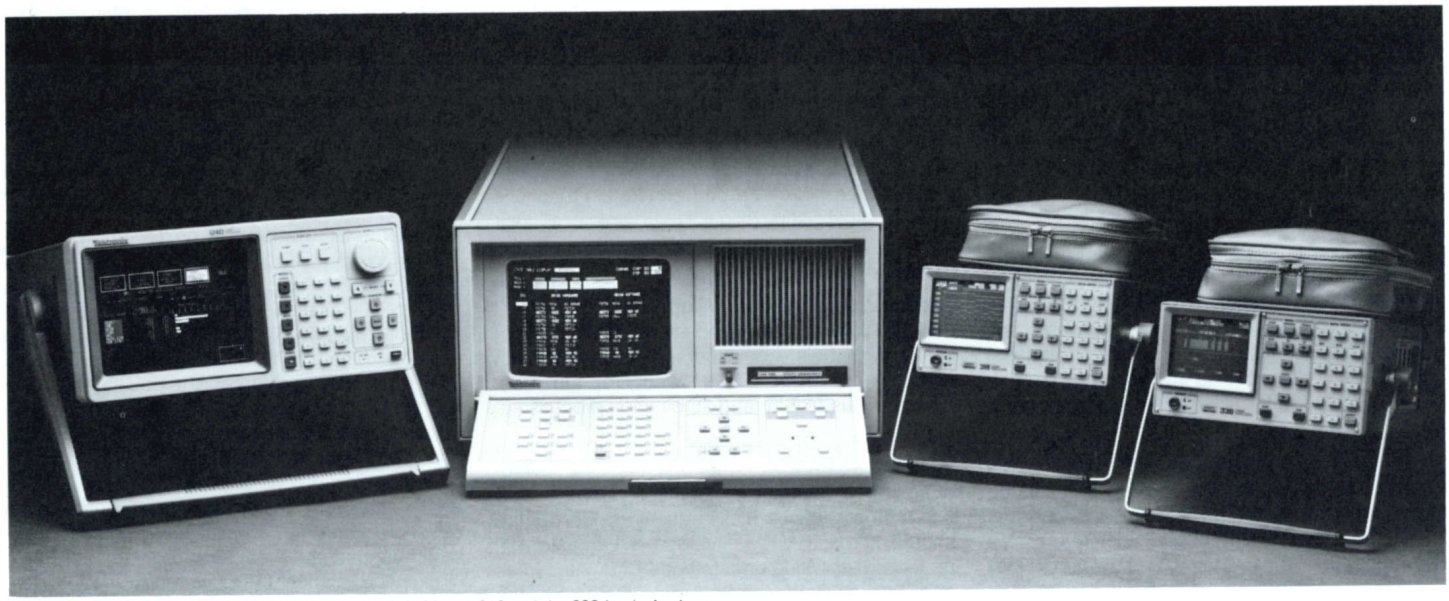
The LANDS PASCAL compiler contains many enhancements aimed specifically at microcomputer programming. This includes features such as data manipulation of the bit level, assignment of variables to specific hardware addresses and direct access to I/O ports. Also, a separate optimizer pass can significantly reduce code volumes and boost performance.

LANDS also includes a unique tool for implementing the hardware/software interface called the ICS (Integration Control System). The user simply responds to a menu or creates a brief file which outlines the parameters of the hardware/software interface. The ICS then automatically handles the details, such as creating the linker command file, interrupt handling code and reset/initialization code.

For hardware/software integration tasks, LANDS includes PASCAL Debug, which elevates all debug operations to the PASCAL source code level. This completely eliminates the need to translate assembly-level debug information into its level counterpart.

Real-Time Emulation Support
The 8561 is designed for easy interfacing with the Tektronix 8540 Integration Unit, which provides real-time emulation for the entire range of Tektronix 8-bit and 16-bit chip support. Code developed on the 8561 is downloaded to the 8540's program memory, up to 128 k, for execution on the emulator processor. Execution takes place under control of powerful debug software, and the resulting data can be uploaded for powerful post-processing by the 8561. For in-depth analysis of real-time code execution, an optional Trigger Trace Analyzer includes sophisticated triggering to capture program flow in a high-speed memory buffer.

LOGIC ANALYZERS



The Tektronix LA Family includes the 1240, the DAS 9100, the 318 and the 338 Logic Analyzers.

CONTENTS

Introduction to Logic Analysis 60
DAS 9100 Series Logic Analyzers 64
1240 Logic Analyzer 70
300 Series Logic Analyzers 75
7D01 Logic Analyzer 79
7D02 Logic Analyzer 80
PM 100 Personality Modules 81
Microprocessor Support 82
Logic Analyzer Probes and Accessories 84

From its origins a decade ago the logic analyzer has emerged as the preeminent tool for design, evaluation, manufacture, and maintenance of digital equipment. Today logic analyzers are found throughout the electronics world, with the same universal acceptance as the oscilloscope and the voltmeter.

The applications for logic analyzers are widespread. Some users require portable, lightweight instruments for field service, while others require larger, more versatile benchtop units for laboratories and manufacturing areas. To meet these various requirements, Tektronix offers a broad family of logic analyzers consisting of four different product lines.

The DAS 9100 Series is truly worthy of its name—Digital Analysis System—offering three mainframes, four types of acquisition modules, pattern generation, tape cassette storage, and an optional systems interface.

Easily portable and rugged, the new 1240 mainframe has two types of data acquisition modules, RAM/ROM pack data analysis and storage, modular COMM pack system interfaces, and the world's first true dual-timebase capability.

The monolithic, ultra-portable 300 Series includes the 308 plus two new models: the 318 and the 338. All three instruments feature both serial and parallel data acquisition, outstanding packaging, and very high performance.

The 7000 Series provides two tried and true analyzers packaged as plug-in modules for 7000 Series oscilloscope mainframes.

All Tektronix logic analyzers feature ease of use, because we believe the logic analyzer should allow the user to concentrate on solving problems rather than on how to operate the analyzer. Clear screen displays, menu-formatted operator interfaces, straightforward keyboard layouts, and simple, reliable mass storage media all contribute to the overall ease of use. This is further enhanced by such industry firsts as the color display in the DAS and the touch-screen soft keys in the 1240.

Today many digital designs are built around one or more microprocessors. To simplify the analysis of such systems, Tektronix offers the widest variety of single-plug microprocessor probe connections and disassembly software on the market. The 1240 Dual Timebase allows you to capture synchronous data from two different microprocessors simultaneously. You can even define a trigger sequence interdependently between the two timeframes!

Another industry first is the ability to design your own disassembly to run on the DAS 9100. This supports custom or proprietary processor designs while maintaining complete confidentiality.

ARCHITECTURE OF LOGIC ANALYZERS

The following paragraphs describe some of the operational sections found in logic analyzers. As shown in Figure 1, there are six main sections in conventional analyzers: input, real-time preprocessing, memory, clocking and triggering, display, and control. In the DAS 9100, Tektronix has introduced a seventh section, the industry's first pattern generation. Also, Tektronix logic analyzers include a very important eighth section: post processing.

Input

Today logic analyzers have from 8 to more than 100 parallel inputs. Typically, the inputs are grouped in 8 or 9 channels per probe. The threshold voltage for the inputs is variable to allow for the wide variety of logic devices in use. Each probe also includes an external clock input and/or qualifier input, as well as ground reference lines.

Because of the special needs for various signal types, a variety of probe and accessory hardware has been developed. For very high-speed signals, short leads are connected to hybrid input circuits for maximum signal fidelity. To analyze complex parts such as microprocessors, personality modules provide a reliable, prewired, single-connector interface to the microprocessor. In fact, you can wire your own Universal Processor Interface Kit (see page 86) to provide a customized single-plug interface to your particular circuit.

Real-Time Preprocessing

Because of the large amount of data in a digital system, preprocessing is often necessary. Clock qualification is the process of sorting data in real time, based on the state of a control signal(s).

Clock qualification sorts the data according to the time relationships to other bus signals. For example, clock qualifiers help determine when data is valid on a multiplexed bus, allowing the analyzer to store bus data only during specified valid data intervals.

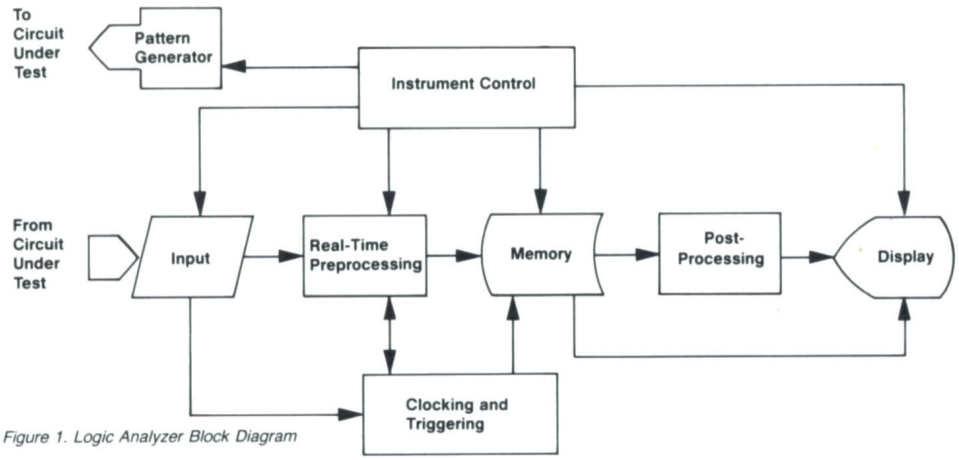


Figure 1. Logic Analyzer Block Diagram

Data qualification is the process of sorting the data in real time based on the content (value) of the data, rather than the time of occurrence. Data qualification allows you to store only certain kinds of data, such as accesses to certain memory locations or I/O ports, or the execution of specific subroutines.

Both clock and data qualification reduce the amount of data stored, thereby reducing analysis time and increasing the effective size of the acquisition memory.

Memory

Logic analyzers can have three separate memories: acquisition, glitch, and reference. The acquisition memory stores the data acquired from the circuit under test. Data is acquired and loaded into memory continuously, writing over previous data until a trigger event terminates the acquisition.

For timing measurements, the acquisition memory may be a dual memory. One memory stores acquired data while the other stores acquired glitch information.

Reference memory is used to store a pattern for comparison. Such a pattern can be acquired either from a circuit operating properly or from an off-line source such as a simulator. When the contents of the acquisition memory are compared with the contents of reference memory, the differences are highlighted so you can see the errors easily.

Clocking and Triggering

The clocking and triggering area contains word recognizers and qualifiers that define the trigger event. The trigger event stops the data acquisition and serves as a reference point in the acquired data. This part of the analyzer also contains circuitry to clock the data acquisition.

In logic analyzer terminology there are two modes of clocking: synchronous and asynchronous. In synchronous mode the analyzer is clocked from the circuit under test. Since, in most digital systems, events in the circuit are driven by a system clock, the logic analyzer must use the system clock to detect events. In asynchronous mode the acquisition clock is provided by the analyzer, so there is no synchronization with the circuit under test (except the trigger event). Asynchronous clocking allows the analyzer to sample the data at faster rates than the system data rate, thereby providing time resolution of events occurring faster than the system clock rate. Synchronous clocking is usually used for watching state flow related to software. Asynchronous clocking is usually used to acquire hardware timing information.

The trigger signal is derived from a variety of word or event recognizers. Since triggering is a complex subject—and it has been made even more complex by the wide variety of terms used by different logic analyzer manufacturers—let's start with a simple example and then consider the possible extensions.

Simple word recognition is the ability to recognize a single event defined by a word made up of selected input channels. For example, a 64-channel logic analyzer can have a word recognizer register of up to 64 bits that describe an event.

Sequential word recognition is the natural extension of simple word recognition. Simple events are combined sequentially to define a compound event. For example, if you expect events A, B, and C to occur in that order, you can set the trigger to look for a valid output from word recognizer A, followed by a valid output from word recognizer B, followed by a valid output from word recognizer C to trigger and end the acquisition. The trigger will occur only after all three events have occurred in the proper order.

Sometimes you want to monitor conditional branching. For example, event A might occur, followed by event B, followed by either event C or event D. Program flow might often include event A and B, with the choice between C and D determining the next sequence of events.

Event counters and delay timers increase the versatility of the logic analyzer trigger. An event counter counts the number of occurrences of an event. Using the event counter, you instruct the logic analyzer to trigger only after the nth occurrence of the event. A delay timer works similarly, except that the trigger is delayed a given length of time rather than waiting for the nth event.

Event duration filters are useful to define hardware events. For instance, you might want to trigger on a combination of pulses only if the combination remains valid continuously for some minimum time. A filter delays triggering until the condition has been true for the minimum time specified by the filter.

Trigger arming allows a logic analyzer to acquire data based on two different clocks. One section of the analyzer monitors data lines at the system clock rate until a trigger event is found. It then arms another section of the analyzer running at a high asynchronous clock rate.

Arming is useful for investigating high-speed hardware phenomena such as control pulses to a microprocessor. When the analyzer section monitoring the address lines at slower speed finds the proper trigger event, it enables the other analyzer section running at higher speed to take a high-resolution look at the control lines. Note that both synchronous and asynchronous clocking are required.

The new Tektronix 1240 is the first logic analyzer to offer a true dual timebase. A dual timebase allows a single analyzer to behave like two completely independent analyzers, with whatever interdependencies you define. For example, if you want to acquire data from two different buses in a system, each part of the analyzer can acquire data synchronously from one of the buses and the analyzer will time-correlate the two sets of data to provide a global picture of system operation. Of course, a dual-timebase analyzer also allows trigger arming operations, as defined above. The dual timebase makes the 1240 particularly valuable in system integration activities.

Display

There are two basic types of output display: timing diagrams and state tables. In the timing diagram, the data stored in memory is used to construct a multi-trace waveform drawing similar to a multi-channel display on an oscilloscope. The timing diagram is usually the preferred method of observing data acquired asynchronously at high speeds to locate hardware faults.

The state table displays data describing the state of the circuit under test in tabular form. It is the preferred output for synchronous data. The state table is much more readable if the data can be grouped into fields and displayed in octal, hexadecimal, or character codes (e.g., ASCII), as well as in binary format. Also, the ability to group the data in fields relating to the circuit under test, rather than to the logic analyzer probes, makes it easier to understand what is really happening.

Post Processing

Post processing of data acquired by a logic analyzer allows the user to analyze deeper relationships in the data and to understand the display more readily. Two examples of post processing are mnemonic disassembly and performance analysis.

Mnemonic disassembly displays the data in the state table in much more readable form. For example, it is much easier to understand the event flow of a microprocessor when the instruction codes are shown rather than the numerical machine codes. This is also true for messages in a character code such as ASCII and for transactions on a bus such as the GPIB. Although some mnemonic disassembly tables may be built into the hardware of the logic analyzer as you purchase it, it is very helpful if you can enhance the analyzer's basic capability either by adding additional pre-programmed mnemonics (such as the ROM packs on the 1240) or by defining your own mnemonics (as on the DAS 9100).

Performance analysis sorts and organizes the data for meaningful statistical readout. For instance, you can obtain statistical data on how often a certain routine is accessed, or on how long your system takes to respond to an interrupt, all within a real-time, real-world operating environment.

Instrument Control

Logic analyzers have many powerful features which can be applied quite flexibly. To make the best use of this power, you must be able to setup the instrument easily, capture the data you

want, and then process and display the data in the manner you desire. To make your job easier, Tektronix has introduced many innovative human interface features. Large, easily readable displays make it easy to find the data. Straightforward, easy-to-read keyboards use color coding to highlight keys in functional groups. In fact, wherever it makes sense, Tektronix analyzers use the same keyboard and menu layouts so that expertise learned on one model carries over to the rest of the family. And finally, Tektronix continues to innovate with such features as the color display on the DAS 9100 and the touch-screen soft keys on the 1240.

A very helpful analyzer feature is the ability to store setup information and acquired data in some non-volatile manner. Tektronix analyzers use a variety of methods, including tape cassettes, battery-backed RAM packs, and non-volatile memory inside the analyzer itself. By storing and reusing setups, you can easily set up the analyzer to do specific tasks. Acquired data that has been stored can be analyzed conveniently at some later time. This saves considerable time in communicating observations to others; instead of describing what he saw, the user can actually show someone else the reconstructed data. Of course, transportable media also simplify the transfer of setups from one instrument to another.

An important aspect of the control of logic analyzers is the interface to external controllers and peripherals. The instrumentation user can save significant time as intelligent instruments talk to each other to speed up the testing process. Also, the ability to work with controllers, either on-site or at remote locations, allows the same instrument to be used optimally in design, manufacturing, and service.

Pattern Generation
The traditional logic analyzer acquires data from the circuit under test. Obviously, to acquire meaningful data, you must ensure that something meaningful is happening at the circuit. In the past a lot of time has been expended to develop separate stimulus fixtures to drive the circuit under test. This is true especially during the early stages of design when the circuit cannot be tested in the environment of other known good circuitry.

The DAS 9100 is the first logic analyzer with both stimulation and acquisition in the same instrument. Using the DAS 9100 saves significant time since programs to stimulate circuits are set up in the same way the rest of the logic analyzer is set up—with prompted menus.

Because the pattern generator allows algorithmic generation of data, a relatively short program can create a much larger sequence of data to drive the circuit under test. The pattern generator can be programmed to behave like the environment in which the circuit is to be used, so that the designer can test parts of a circuit design before all the prototypes are ready. In addition, the tests created for the pattern generator can ultimately form the basis for evaluation, manufacturing, and service tests.

PERFORMANCE

The right logic analyzer for you is primarily a function of your application. The following paragraphs describe some of the more common applications of logic analyzers and their performance requirements.

Microprocessor Analysis
Although microprocessors come in many shapes and sizes, they have some common characteristics: data rates comfortably below 10 MHz, bus-oriented architectures, and some type of mnemonic programming language. Moreover, to achieve economy of scale for both producers and users of microprocessors, there is a tendency to settle on relatively few basic designs, from which enhanced versions evolve. Nevertheless, some applications demand performance unattainable in standard commercial microprocessors. To satisfy these applications, engineers are developing custom processors, based on unique IC's and/or bit-slice components.

A logic analyzer for microprocessors should be capable of state analysis with the ability to track relatively complex event sequences for triggering, so you can capture data from specific events within the operating environment. For timing analysis, the asynchronous sampling rate must be at least 5 to 10 times faster than the data rate.

The analyzer should allow you to assign channels to meaningful groups, such as "data," "address," and "control," regardless of the actual physical channel assignments. For display, the analyzer must have mnemonic disassembly capability. Sometimes this capability is achieved by large amounts of specific hardware and firmware for each microprocessor, resulting in large expenditures for every additional microprocessor supported. A better method is for the analyzer to have as much general purpose microprocessor support as possible, with minimal specialization for the specific microprocessor.

If you want to support a non-standard processor, such as a proprietary chip or a proprietary bit-slice design, then you need all of the microprocessor features above, with added emphasis on the ability to connect to your circuit and to develop unique disassembly tables. EDM (Extended Define Mnemonics) on the DAS 9100 allows you, the user, to create disassembly tables for your own unique circuit design. The Universal Probe Interface Kit (page 87) also allows you to create your own custom-wired, single-plug connection for your processor.

High-Speed Logic
As circuits become faster, you need a logic analyzer which tells you as much as possible about the timing of your circuit. With up to 8 channels at a sampling resolution of 1.5 ns, the DAS 9100 helps you solve many problems without resorting to your oscilloscope and trying to correlate the data from two or more different instruments.

Complex On-Site Service
Achieving portability in an instrument always involves a set of trade-offs—usually performance versus weight and size. For maintaining sophisticated systems, such as large computers, performance is necessary but the usefulness of an instrument is severely limited if it is too large and heavy to be moved easily. The 1240 was designed to meet the military class 3 specifications for ruggedness and dependability and to fit under a standard airplane seat. Yet it can be configured for up to 36 channels at 100 MHz or 72 channels at 50 MHz, and it supports complete remote interface to either a central controller or to another 1240. The "master-slave" connection of two similar instruments, available for both the 1240 and the DAS 9100, helps improve the pro ductivity of your maintenance engineers by minimizing the expense of the on-site resources without compromising quality.

Ultra-Portability
Sometimes weight and size are of utmost importance. Weighing only 11 pounds, the Tektronix 300 series instruments are optimized for ultra-portability. The 318 and the 338 each offer state, timing, and serial analysis. The 308 has only eight channels but offers signature analysis as well as state, timing, and serial formats. Anyone who has to carry an analyzer around will appreciate the superb packaging of these high quality analyzers.

System Integration
Bringing together hardware modules and software modules sometimes seems like a great "whodunnit" game. To sort out your system, you need to monitor many different points and time-correlate data gathered from different system areas. The ability to gather state and timing information simultaneously allows you to form a more complete picture of system operation. Pattern generation saves time by allowing you to simulate signals to check system response. Dual-timebase operation makes it easier to describe system events, capture data, and determine problem causes. Finally, performance analysis converts data into information by providing statistical summaries of data about system events.

Tektronix helps you with system integration with a number of specific analyzer features. The DAS 9100 offers up to 104 channels with data speeds from 10 MHz to 660 MHz, "arms" mode to time-correlate state and timing data, and pattern generation to simulate missing system signals. The 1240 offers easy portability, dual-timebase operation to time-correlate different system events, and performance analysis firmware to analyze overall system activity.

Manufacturing Test
After your engineering team finishes the design, the manufacturing team takes over to produce the product. You will undoubtedly be interested in correlating manufacturing activity to the design standards of your product. A logic analyzer that can be used in both engineering and manufacturing facilitates the transfer of information and the correlation of testing results. The DAS 9100 is an ideal vehicle for transferring evaluation tests into manufacturing. Since the DAS 9100 includes pattern generation, it functions as both stimulus and measurement system to drive the test environment for your products or subassemblies. Also, the DAS 9100 is completely programmable from a controller so it can be integrated into systems with other test and measurement equipment.

Component Testing
If you have just developed a new VLSI chip, you may need a VLSI test system to make a complete investigation of the behavior of your part. But to make such a test you'll typically need weeks to develop a program and to get time on a large VLSI tester. In the meantime, the DAS 9100 can stimulate and monitor your device—with up to 80 pattern generation channels and up to 96 acquisition channels in a single mainframe—to make a preliminary test of functionality before developing more thorough tests on the large tester.

SELECTION GUIDE

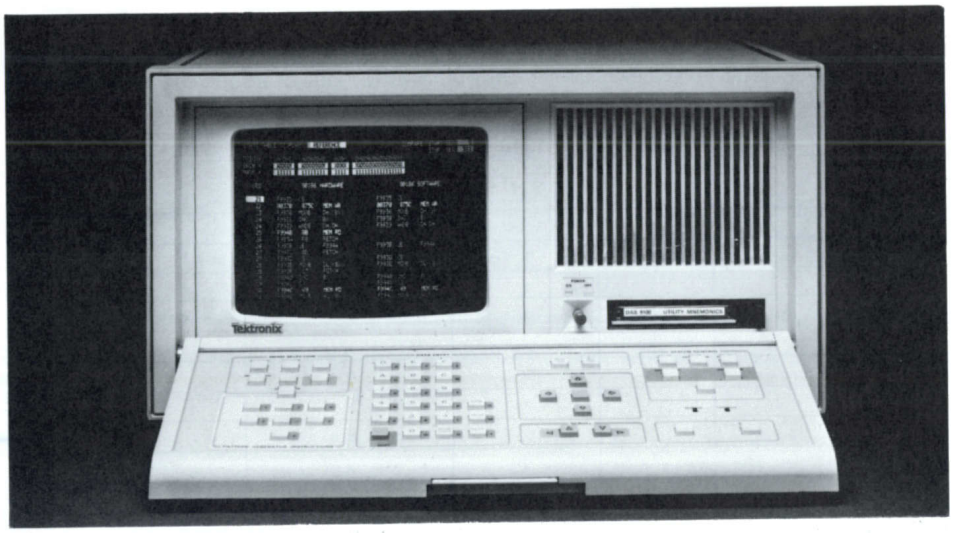
The right logic analyzer for you is the one which best meets the needs of your applications, present and future. To assist you in finding your optimum solution, the following selection guide compares some of the capabilities of the Tektronix logic analyzer family. After reading the chart, you can get further information by referring to the description of the appropriate model.

APPLICATION/FEATURE	308	318	338	1240	DAS 9100	7D01	7D02
Microprocessor and Bus Analysis:							
Trigger on simple program execution	x	x	x	x	x	x	x
Trigger on complex program execution		x	x	x	x		x
Trigger on execution time or state count				x			
Measure execution time or state count				x	x		x
Qualify clock inputs	x	x	x	x	x	x	x
Qualify on data value				x	x		x
Qualify on entry/exit from data block				x	x		
Relate program execution to asynchronous control				x	x		x
Simultaneous state and timing acquisition				x	x		x
Time-aligned state and timing display				x	x		
Simultaneous state and state acquisition				x			
Time-aligned state and state display				x			
Microprocessor personality modules				x	x		x
Microprocessor mnemonics				x	x		x
User-definable mnemonics					x		
Line printer output				x	x		
Stimulate bus transfers					x		
Acquire and analyze serial data up to 9.6 kbaud	x	x	x				
Acquire and analyze serial data at 19.2 kbaud		x	x				
Analyze GPIB transactions				x	x	x	
Stimulation:							
Programmable outputs					x		
External control lines					x		
Synchronous clock output					x		
System Integration and Debugging:							
Synchronous acquisition sampling rate	20 MHz	50 MHz	20 MHz	50 MHz	10/25/100/330 MHz	50 MHz	10/20 MHz
Asynchronous acquisition sampling rate	20 MHz	50 MHz	20 MHz	50/100 MHz	10/25/100/660 MHz	100 MHz	50 MHz
Glitch capture	x	x	x	x	x	x	x
Glitch triggering		x	x	x	x		x
Simultaneous state and timing acquisition with time-aligned display				x	x		
Simultaneous state and state acquisition with time-aligned display				x			
Simultaneous timing and timing acquisition with time-aligned display				x			
Test fixture elimination					x		
Performance analysis				x			
Manufacturing Test:							
Stimulation and acquisition					x		
Easily transportable storage media				RAM Pack	Tape		
Pre-programmed standard set-ups		Internal	Internal	ROM Pack	Tape		
Controller interface		RS-232	RS-232	COMM Pack	RS-232/GPIB		
Service:							
First line on-site	x	x	x	x			
Permanent on-site	x	x	x	x	x		
Depot level	x	x	x	x	x		
Remote control via master/slave				x	x		
Remote control via host controller	x	x	x	x	x		
System Interface Capabilities:							
Trigger Input and Output	x	x	x	x	x	x	x
Video output for hard copy or monitor		x	x	x	x		
Programmable via RS-232		x	x	x	x		
Programmable via GPIB				x	x		
Modular and easily expandable				x	x	x	
7000 Series compatible						x	x

For more information, contact your Tektronix DAD Sales Engineer.

NEW

LOGIC ANALYZERS



DAS 9100 SERIES

Digital Analysis System

Color Display Enhances Ease-of-Use and Increases Productivity

The Industry Leader in Performance and Flexibility

Acquisition Speeds to 660 MHz (1.5 ns)

Data Widths to 104 Channels

Pattern Generation up to 80 Ch @ 25 MHz

Color, Monochrome and ATE Mainframes

Modular Architecture to Keep You State-of-The-Art

Disassembly Support for Over 30 Microprocessors and Buses

Memory Depths From 512 to 4096 Bit Per Ch

Patented EDM Disassembles Proprietary Processors and Buses

Select Triggering to 16 Levels

Patented Time Correlation of High-And Low-Speed Data

Separate Glitch Memory

State-Table and Timing Diagrams Displayed for all Channels

Pattern Generation to Simulate Hardware or Software

Menu-Driven Operation that Never Needs A "Help" Function

Delta Time and Auto-Run Mode

Supports GPIB, RS-232, Hard-Copy Units and Serial Line Printers

Tape Drive Stores Patterns and Instrument Set-Ups

Select the Performance and Price that Meets your Application Needs

The Industry Standard

The DAS 9100 Series Digital Analysis System has set the industry standard for virtually all aspects of logic analysis. Its modular mainframe accepts a wide assortment of both data acquisition and pattern generation modules to fit your application needs. You get performance combinations unavailable in any other logic analyzer, including data widths to 104 channels and acquisition speeds up to 660 MHz. Another DAS 9100 innovation is the inclusion of pattern generation modules, up to 80 channels, which can be used in concert with data acquisition modules to perform sophisticated test procedures.

The DAS 9100 Series supports this superior performance level with an exceptionally advanced user interface, which includes the first color display found on a logic analyzer (a monochrome version is also available). The operating system supplies easy-to-use menus for fast, simple operation. For microprocessor applications, an ongoing series of chip support packages adapt the interface to the particular processor you're working with, either commercial or custom.

Also, the DAS is unmatched in its ability to adapt to almost any engineering work environment. It has the capacity to interface with mainframes, GPIB controllers, development systems and other DASs. For stand-alone situations, there's a built-in tape storage unit and the DAS outputs to both hard copy units and serial line printers.

The Leader in Ease of Use

The DAS 9100 has an unmatched feature set that makes it the undisputed leader in ease of use. The Color DAS 9129 is currently the only logic analyzer available on the market with a color-coded CRT. Each of the instrument's setup menus and data displays are organized into color groups which promote faster interaction, better understanding, reduce chance of error and minimize fatigue.

The color coding scheme is the product of intensive research by Tektronix into the use of color to enhance user productivity during interaction with a CRT display. The CRT supports three colors, red, yellow and green, plus the black background. These color phosphors fall within a common focal depth, which means the eye does not have to refocus when scanning from one color to another.

See this color product in the reference section beginning on page 9.

Green (a "quiet" color), is used to display supporting information in an unobtrusive manner. Yellow (a more agressive color), is applied to information of immediate interest, such as acquired data. Red, which attracts immediate attention, is reserved for exceptional situations, such as marking the trigger point in a data stream or listing illegal instructions during a disassembly.

Both the Color DAS and its monochrome counterpart have a menu-driven operating system which vastly simplifies all user interactions. Each particular function, such as trigger setup or pattern generation programming, has its own menu which is largely self-explanatory. The user simply moves the cursor to the appropriate video fields and supplies the required information. There is no need for lengthy manual references to master the instrument's operation. When a menu entry falls outside acceptable bounds, a message appears which explains the specific nature of the error, thus allowing simple recovery without the need for a separate help function.

The operating system also includes features which promote fast accurate analysis of acquired data. A reference memory compare color-codes all differences between acquisition and reference memories. The Delta Time feature allows precise measurements of the time interval located between movable cursors.

A major benefit in most engineering situations is the ability to retain instrument setups and reference data for future use. The DAS 9100 has a built-in DC 100 cartridge tape drive, which retains complete instrument setups as well as reference memory data and mnemonic definitions tables used to disassemble acquired data. All tape drive I/O operations are accomplished through a simple, menu-driven filing system.

The DAS also has a host of other features which promote ease of use, such as a full line of probes that simplify connections to almost any type of device.

8-Bit and 16-Bit Microprocessor Design Support at its Best

In response to the overwhelming need for good microprocessor design support in logic analysis, the DAS 9100 Series offers a greater depth and range of microprocessor-based support than any other analyzer.

The key to this support is the DAS 9100's new Extended Define Mnemonics, which allows the unit's built-in DC 100 tape drive to act as a storage medium for mnemonic tables for 8-bit, 16-bit and even custom processors.

EDM (Extended Define Mnemonics) is a powerful, table-driven program which is part of the DAS firmware. EDM performs disassembly of data acquired synchronously off a microcomputer system bus. EDM uses a series of nested tables to complete the disassembly. All address, data and control information is received by a master table and passed down through a hierarchy of tables which converts it into disassembled mnemonics. For custom processors, you can create your own set of tables. For commercial processors, Tek has a wide array of both 8-bit and 16-bit EDM tapes available, which will automatically complete the disassembly for you.

NEW

LOGIC ANALYZERS

Select from one of the following support packages or use EDM to create a disassembly program for your own custom processor:

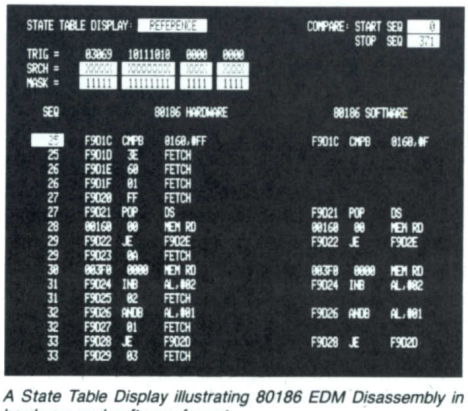
8080	6805	6502
8031	6808	65C02
8039	6809	1802
8085	68121	1805
8086	68000	NSC800
8088	68008	F9450
80186	Z80	1750A
80188	Z8001	UNIBUS
6800	Z8002	Q-Bus
6801	Z8003	GPIB
6802	Z8004	ASCII
6803		EBCDIC

NOTE: For Ordering Information consult the microprocessor support section on pages 82 and 83.

Each 8-bit EDM disassembly tape includes a full set of disassembly tables and also a file containing all the setup parameters needed to have the 91A24 data acquisition modules acquire software transactions as executed on the system bus. For even further convenience, there is a Probe Interface Adaptor which allows all probe hookups to the processor to be completed in a single connection.

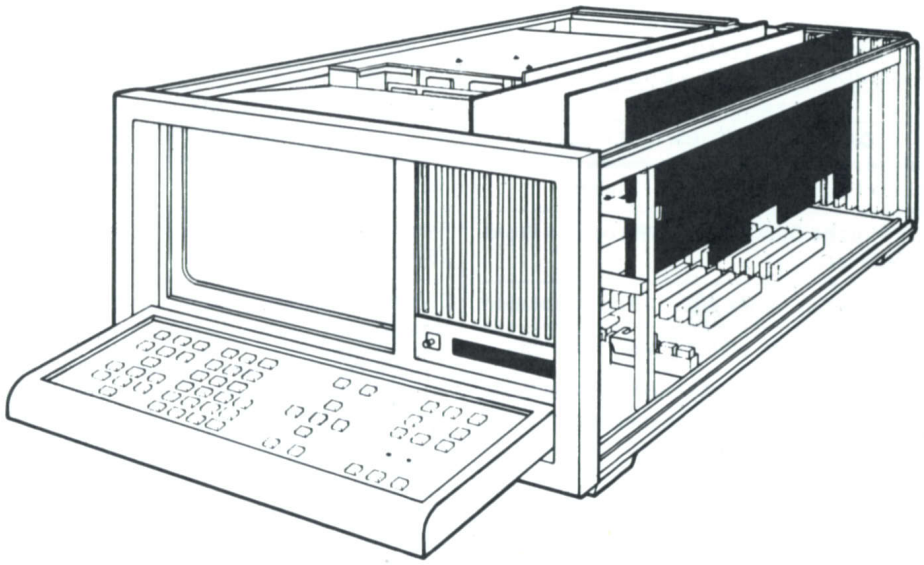
At the 16-bit level, EDM tapes are used in conjunction with the new PM 200 Series to complete the disassembly. Each PM 200 module probes the 16-bit processor under test and uses discrete logic to interpret data flow for disassembly, including operations such clock synthesis and monitoring the fetch queue. The acquired data is then passed on to the DAS itself for triggering and storage in acquisition memory.

Only the DAS 9100 allows you to select the disassembly format you need: Software, hardware or absolute.



A State Table Display illustrating 80186 EDM Disassembly in hardware and software format.

At both the 8-bit and 16-bit level, EDM has a powerful and flexible feature set which makes the DAS 9100 the leader in software analysis support. EDM gives you three distinct types of disassembly: Software disassembly, which presents software flow in a similar format to an assembly listing; hardware disassembly, which shows mnemonics along with all processor cycles; and absolute disassembly, which identifies each bus cycle by type and gives the hexidecimal values associated with each cycle. EDM also allows user selectable color coding of displayed data and the addition of comments and labels. You can even use disassembly mnemonics when defining triggers with the 91A24 trigger menu.



For complete configurability, the DAS mainframe houses up to six card modules. Each card slot can hold one of eight different data acquisition and pattern generation modules.

SELECT YOUR CONFIGURATION

The DAS 9100 has six different data acquisition modules. Each has its own data width and maximum speed: 24 channels at 10 MHz for software analysis (96 channels maximum); 32 channels at 25 MHz (96 channels maximum); 8 channels at 100 MHz with glitch memory (32 channels maximum); 4 channels at 330 MHz (16 channels maximum) or two channels at 660 MHz (8 channels maximum). Modules can be combined to give you the logic analyzer you need.

Need high speed performance? One module can track your system clock (synchronously) at speeds to 330 MHz or provide asynchronous sampling to 660 MHz. The 8-channel module provides both synchronous and asynchronous sampling at 100 MHz. And the 32-channel or 24-channel module can be used to arm the trigger on those modules with higher acquisition rates.

To back it all up, there's powerful triggering, clock and trigger qualification, programmable reference memory and multiple clocks. There is glitch triggering, with a separate glitch memory for unambiguous glitch detection and our unique, new "arms mode" that allows precise timing correlation between synchronous and asynchronous data.

Arms mode allows the DAS 9100 to capture synchronous and asynchronous data simultaneously. The data is displayed in the correct time relationship for easy analysis in either Timing or State Display mode. To obtain the data width and speed your application requires, simply select the appropriate combination of modules and add on later as your needs change.

To enhance the tool set, the define mnemonics menus allow the user to build disassembly tables to support proprietary and other non-supported chips. Up to 64 tables with 256 entries per table can be nested to provide the capability to support complex 16-bit processors, with room left over!

Pattern generation makes it possible to start debugging hardware before your software, or all of your hardware, is available.

Pattern generation capability is built around a 16-channel, 25 MHz controller module. Through additional expansion modules, you can increase the total to 48 or 80 channels while maintaining full system speed. The pattern generator allows interaction with the prototype through clock outputs, data strobes, an external clock, and external control inputs, including an interrupt line. And, the pattern generated can even be changed, based on the data acquired by the logic analyzer, through the external control lines.

The DAS 9100 also offers you powerful I/O options, including a built-in magnetic tape cartridge drive (Option 01) to store instrument setups, pattern sequences, mnemonics and reference memory. The RS-232 and GPIB interface (Option 02) offers complete remote programmability and a hard copy interface is also included.

The new I/O Option 06 has all the capabilities of option 02 plus enhanced high-speed GPIB for ATE applications up to 200 kbytes per second transfer rate. Option 06 also provides an RS-232 line printer port for the DAS to allow for easy documentation of menu displays, EDM tables, state tables and timing diagrams.

Options 03 and 04 allow you to add one or two additional modular power supplies (each supply powers two slots). The standard DAS mainframe comes with a power supply for two slots. You only pay for the capability you need.

The DAS 9100's modular performance provides capabilities for a variety of applications. Data acquisition modules offer unsurpassed performance in high-speed timing analysis and bus analysis. And now, the integration of pattern generation modules opens up a new realm of logic analysis applications in design, manufacturing and ATE.

See pages 66 and 67 for DAS 9100 module and option selection guide.

NEW

LOGIC ANALYZERS

DAS 9100

NEW SOFTWARE ANALYSIS MICROPROCESSOR & BUS SUPPORT

91A24 and 91AE24

DATA ACQUISITION MODULES

- 16 Level Sequential Trigger Tracing
- Data Storage Qualification With up to 4 Word Recognizers
- 32 Bit Counter/Timer With 100 ns Resolution
- 24 Data Channels With 1 K Memory Depth
- 3 External Clocks and 3 Qualifiers With Independently Programmable Expressions
- Single Probe Demultiplexing
- Synchronous or Asynchronous Acquisitions Down to 100 ns Data Cycles
- Supports Over 30 Microprocessors and Buses With 91TMXX Support Series (Page 83)

For software analysis, the new 91A24 data acquisition module provides advanced triggering and clocking. It employs five independent word recognizers which includes a 16 level stack that lets you build the complex triggers and data qualifiers necessary to debug involved software routines.

Maximum Modules Per DAS — One 91A24 maximum per DAS mainframe, three 91AE24 maximum per DAS mainframe (requires 91A24 to operate).
Maximum Number of Inputs — 24 data channels expandable to 96 channels with one 91A24 and three 91AE24 modules.
Maximum Sampling Rate — 10 MHz internal or external clock, 100 ns cycle time.
Memory Depth — 1023 bits per channel.
Reference Memory — 1 k by 48 channels formattable to 512 by 96 channels, compare with acquisition, trigger on compare equal or not equal, column masking and programmable compare window.
Clock Qualifiers — Three available on 91A24 only. Selectable polarity for each of three POD clock expressions.
Clock — Selectable from one internal or three external sources.
Internal: 100 ns to 5 ms ±01% ±01 ns.
External: Three clock inputs, 20 MHz maximum, selectable rising or falling edge for each of three independent Boolean clock expressions, one expression per POD memory, [(CLK1 • Q1) + (CLK2 • Q2) + CLK3] • Q3, Demultiplex mode with 50 ns DEMUX interval minimum and 100 ns cycle minimum.
Triggering — 5 independent word recognizers with selectable operating modes:
WR1 — Begin store or store only data qualifier.
WR2 — Begin store or store only data qualifier or parallel trigger event.
WR3 — 16 level sequential trigger stack with occurrence counter and sync output or counter/timer control option at each stack level.
WR4 — END store data qualifier, RESET stack operation, or OFF.
WR5 — END store data qualifier or OFF.
External trigger enable input and trigger sync output.
Trigger Positioning — BEGIN, CENTER, END, or DELAY 1 to 32,767 clocks
Trigger Arming — Arms 91A08 or 91A04A.
Event Counter — Counts from 1 to 4,096 events programmed on individual stack levels.
Probes — P6460 or P6462, three per module; mixing probes is not recommended.
Data Set Up Time — 25 ns minimum using P6460, 29 ns minimum using P6462.
Data Hold Time — 0 ns maximum using P6460, 3 ns maximum using P6462.
Qualifier Set Up Time — 25 ns minimum using P6460, 29 ns minimum using P6462.
Qualifier Hold Time — 0 ns maximum using P6460, 3 ns maximum using P6462.
Counter/Timer — 32 bit, 100 ns resolution START or STOP from stack levels.

SOFTWARE & HARDWARE ANALYSIS GENERAL PURPOSE 25 MHz SUPPORT

91A32

DATA ACQUISITION MODULE

- 32 Channel Data Width
- Synchronous or Asynchronous Sampling to 25 MHz
- 3 Word Recognizers With Occurrence Counter
- 2 Clock Qualifiers and Expandable Clocking
- Arms 91A08 and 91A04A
- Provides Microprocessor Support Via The DAS PMA 100

In many instances, the engineer's goal is to monitor overall logic activity on the system bus. Here the 91A32 data acquisition module becomes an ideal choice. It combines a 32-channel data width with sample rates up to 25 MHz. To define and capture various types of bus transactions, each 91A32 module has three levels of triggering and two clock qualifiers. Up to three 91A32 modules may be used in a single DAS mainframe, for a total of 96 parallel channels. Working with the PMA 100 and PM 100 personality modules the 91A32 provides both 8-bit and 16-bit microprocessor support plus multibus and general purpose processor support (see page 81).

Maximum Modules Per DAS — Three 91A32 modules max per DAS mainframe.
Maximum Number of Inputs — 32 data channels expandable to 96 channels with three modules.
Maximum Sampling Rate — 25 MHz internal or external clock, 40 ns cycle time.
Memory Depth — 512 bits per channel.
Reference Memory — 512 bits/channel, compare with acquisition, trigger on compare equal or not equal, column masking and programmable compare window.
Clock Qualifiers — Two per module six maximum, selectable polarity.
Clock — Selectable from one internal or up to three external sources.
Internal: 40 ns to 5 ms ±01% ±01 ns.
External: Selectable rising or falling edge, demultiplex split clock mode available with two or three 91A32 modules.
Triggering — Three word recognizers, two provide sequential or independent triggering with occurrence counter, one provides independent reset function. External trigger enable input and word recognizer output.
Trigger Positioning — BEGIN, CENTER, END or DELAY 1 to 32,767 clocks.
Trigger Arming — Arms 91A08 or 91A04A.
Event Counter — Counts from 1 to 32,767 word recognizer events.
Probes — P6452 or P6462, four per module; mixing probes is not recommended.
Data Setup Time — 29 ns minimum using P6452, 25 ns minimum using P6462.
Data Hold Time — 0 ns maximum using P6452, 7 ns maximum using P6462.
Qualifier Setup Time — 29 ns minimum using P6452, 25 ns minimum using P6462.
Qualifier Hold Time — 0 ns maximum using P6452, 7 ns maximum using P6462.

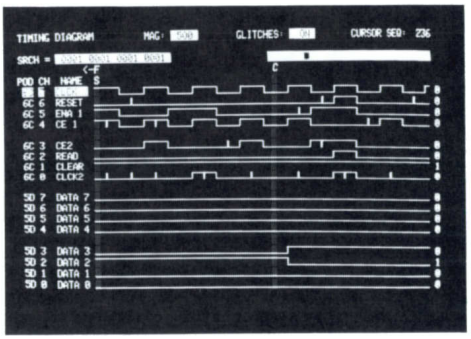
HARDWARE ANALYSIS GENERAL PURPOSE 100 MHz SUPPORT

91A08

DATA ACQUISITION MODULE

- Synchronous or Asynchronous Sampling to 100 MHz
- 8 Channel Data Width Expandable to 32 Channels
- 5 ns Glitch Trigger and Storage
- Separate Glitch Storage Memory
- Trigger Arming From 91A24 or 91A32

Many applications call for asynchronous sampling to observe the status of control lines during bus transactions. For this purpose, the 91A08 data acquisition module serves as an ideal tool. Each 91A08 gives you 8 data channels at sample speeds up to 100 MHz and independent glitch triggering. A single DAS mainframe will accept four of these modules for a total of 32 channels at 100 MHz.



91A08 Timing diagram with glitches

Maximum Modules Per DAS — Four 91A08 modules maximum per DAS mainframe.
Maximum Number of Inputs — 8 data channels expandable to 32 channels with four modules.
Maximum Sampling Rate — 100 MHz internal or external clock, 10 ns cycle time.
Memory Depth — 512 bits per channel with separate 512 bits per channel for glitch storage.
Reference Memory — 512 bits per channel, compare with acquisition, trigger on compare equal or not equal, column masking and programmable compare window.
Clock Qualifier — One per module, four maximum, selectable polarity.
Clock — Selectable from two internal or two external sources.
Internal: 10 ns to 50 ms ±01% ±01 ns.
External: Selectable rising or falling edge.
Triggering — Single level word recognizer and glitch recognizer. External trigger enable using arms mode.
Trigger Positioning — BEGIN, CENTER, END or DELAY 1 to 32,767 clocks.
Trigger Arming — Armed by 91A24 or 91A32.
Probes — P6452, one per module. P6454 external clock probe, one per DAS mainframe.
Data Setup Time — ≤9 ns using one 91A08, ≤10 ns using multiple 91A08 modules.
Data Hold Time — 0 ns maximum.
Qualifier Setup Time — ≤9 ns using one 91A08, ≤10 ns using multiple 91A08 modules.
Qualifier Hold Time — 0 ns maximum.
Glitch Storage — 5 ns minimum glitch width.

NEW

LOGIC ANALYZERS

DAS 9100

HARDWARE ANALYSIS HIGH-SPEED 330 MHz or 660 MHz SUPPORT

91A04A and 91AE04A

DATA ACQUISITION MODULE

- **1.5 ns Sample Interval in Two Channel Modes For 660 MHz Asynchronous Acquisition**
- **Synchronous Aquisition to 300 MHz**
- **Asynchronous Acquisition to 330 MHz on All Channels**
- **4 Data Channels With 2048 Bits Per Channel Memory Depth**
- **4096 Bits Per Channel in Two Channel, 1.5 ns Mode**
- **Trigger Arming From 91A24 or 91A32**
- **Auto-Deskewing Minimizes Channel-To-Channel Skew and Ensures Accurate Setup and Hold**

For high-speed hardware analysis, select the 91A04A data acquisition module which delivers sample speeds up to 660 MHz, the fastest in the industry. This extremely fast asynchronous sample rate gives you a timing resolution of 1.5 ns, fast enough to actually capture and display glitches in their true timing relationship to other signals. Now you can truly analyze where those errant pulses originated.

Maximum Modules Per DAS — One 91A04A maximum per DAS mainframe, three 91AE04A maximum per DAS mainframe (requires 91A04A to operate).

Maximum Number of Inputs — 4 data channels expandable to 16 channels with one 91A04A and three 91AE04A modules.

Maximum Sampling Rate — 660 MHz internal 2 channels only (1.5 ns sample interval), 330 MHz internal clock 4 channels (3 ns cycle time), 300 MHz external clock 4 channels (3.3 ns cycle time).

Memory Depth — 2048 bits per channel; 4096 bits per channel in 2 channel 1.5 ns mode only.

Reference Memory — 512 bits per channel, compare with acquisition, trigger on compare equal or not equal, column masking and programmable compare window.

Clock Qualifiers — None.

Clock — Selectable from one internal or one external source.

Internal: 1.5 ns to 5 ms.

External: Selectable rising or falling edge.

Triggering — Single level word recognizer. (In 1.5 ns mode only trigger word must be valid for one sample period +2.5 ns). External trigger enable using arms mode.

Triggering Positioning — BEGIN, CENTER, END or DELAY by 1 to 32,767 clocks.

Trigger Arming — Armed by 91A24 or 91A32.

Event Counter — None.

Probe — P6453, one per module.

Data Setup Time — 3.0 ns worst case adjustable in 400 ps increments.

Data Hold Time — 0.3 ns worst case adjustable in 400 ps increments.

Qualifier Setup Time — NA.

Qualifier Hold Time — NA.

Channel to Channel Skew — 0.50 ns on rising edges typical, 0.90 ns on falling edges typical.

Minimum Detectable Pulse Width — 3.5 ns worst case.

PATTERN GENERATION GENERAL PURPOSE STIMULUS SUPPORT

91P16 and 91P32

PATTERN GENERATOR MODULES

- **Stimulus Data and Clock Rates to 25 MHz**
- **Data Widths of 16, 48 or 80 Output Channels**
- **Up to 10 Independently Programmable Strobes**
- **Programmable Tri-State Output Control**
- **External Pause, Tri-State, and Interrupt Control Inputs**
- **Vector Count, Hold, Repeat, and Looping Operations**
- **Vector Sub Routine, Nested up to 16 Levels**

Pattern generation makes it possible to start debugging hardware before your software, or all of your hardware, is available. The basic 91P16 Pattern Generator module gives you 16 channels of circuit stimulation at up to 25 MHz, and expansion modules can raise the total to 80 channels.

Maximum Modules Per DAS — One 91P16 maximum per DAS mainframe, two 91P32 maximum per DAS mainframe (requires 91P16 to operate).

Maximum Number of Outputs — 16 data channels and two strobes expandable to 80 data channels and 10 strobes with one 91P16 and two 91P32 modules.

Maximum Stimulus Rate — 25 MHz internal or external clock, 40 ns cycle time.

Pattern Memory Depth — 254 words or instructions, able to output over 65,000 unique patterns single pass or continuous.

External Control Lines — Three available from trigger time base probe.

Pause — Holds pattern output temporarily while asserted, selectable polarity.

Inhibit — Tri-States all outputs while asserted, selectable polarity.

Interrupt — Forces jump to subroutine after asserted. Selectable rising or falling edge.

Clock — Selectable from one internal or one external source and single step operation.

Internal: 40 ns to 5 ms ±01% ±01 ns.

External: Selectable rising or falling edge.

Instruction Set — Seven commands available to program sequence and pattern vector output.

COUNT (N) — Increment A pattern N times, one per clock.

HOLD (N) — Hold pattern output and inhibit clock for N cycles.

REPEAT (N) — Hold pattern output while generating N clock cycles.

GOTO (LABEL) — Output patterns starting at LABEL.

CALL (LABEL) — Call pattern subroutine at LABEL.

RETURN — Return from subroutine call.

HALT — Output pattern and inhibit clock.

Number of (N) Variables — Six maximum.

Number of Labels — 32 maximum.

Number of Nested Subroutines — 16 maximum.

Number of Strobes — Two strobe outputs on 91P16, four strobe outputs on 91P32.

Strobe Pulse Polarity — Selectable positive or negative.

Strobe Delay Time — Selectable from 70 ns to 40.910 μs in 40 ns steps.

Strobe Pulse Width — Selectable from 40 ns to 40.880 μs in 40 ns steps.

Clock Output — One clock line per probe, rising edge signifies beginning of cycle.

Probes — P6455 for TTL/MOS, P6456 for ECL, or P6457 for TTL/MOS with individual bit Tri-State. Two per 91P16 module, four per 91P32 module.

Output Data Skew — ⩽10 ns.

Output Clock Skew — ±5 ns between different probes.

Pause Pulse Width — 19 ns minimum.

Pause Hold Time — 14 ns after output clock transition.

Inhibit Delay Time — 70 ns maximum.

Interrupt Setup Time — 7 ns minimum relative to external clock input, 72 ns minimum relative to output clock.

Interrupt Latency — 4 sequence execution delay.

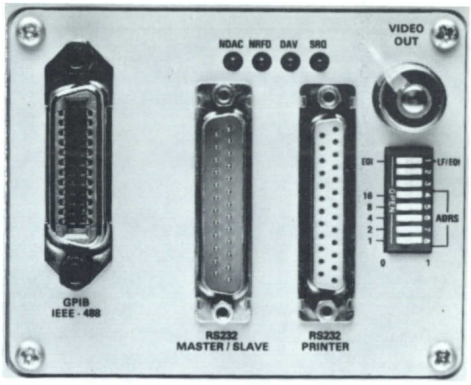
GPIB, RS-232, TAPE DRIVE, LINE PRINTER & HARD COPY SUPPORT

OPTIONS 01, 02 & 06

COMMUNICATION INTERFACE OPTIONS

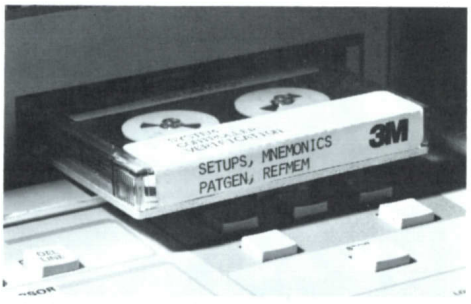
- **High Speed GPIB (200 kbytes/second)**
- **RS-232 Host Interface**
- **RS-232 Line Printer Port**
- **RS-232 Master/Slave Operation**
- **Video Out/Hard Copy Support**
- **DC 100 Tape Drive Local Storage**

The new DAS Option 06 external communications package provides the most complete array of I/O capabilities to handle both computer and peripheral interfaces. It includes high speed GPIB, RS-232 master/slave, RS-232 printer port and hard copy interfaces. In the GPIB mode, host controller supplies all DAS menu setups and receives test results, with the DAS serving either as talker or listener. In the master/slave mode, one DAS acts as the master controller for a second DAS, which may be in a remote location and linked to the master DAS via modem. For stand-alone DAS installations, the RS-232 printer port and hard copy (video) output provide excellent support for making copies of DAS menus and state or timing diagrams.



Rear Communications Interface panel Option 06

DAS I/O Option 02 is similar to Option 06 except its maximum GPIB data rate is 1.2 kbytes/s and there is no RS-232 printer port. All other features are supported.



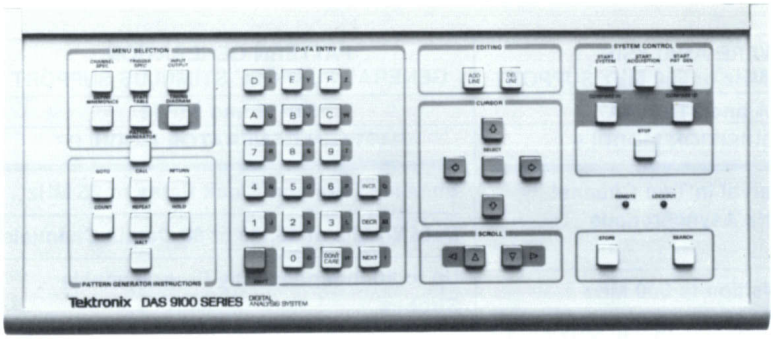
DC 100 Tape Drive Option 01

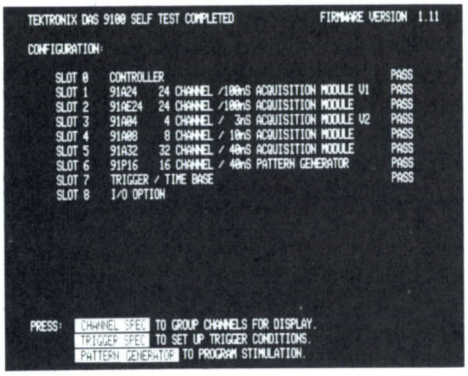
For workstation-type applications, the Option 01 built-in DC 100 tape drive provides convenient, menu-operated local storage and retrieval. It accepts tape cartridges (each holding up to 32 separate files) to store reference data, pattern generation programs, Extended Define Mnemonics tables or data acquisition setups.

DAS 9100 SERIES

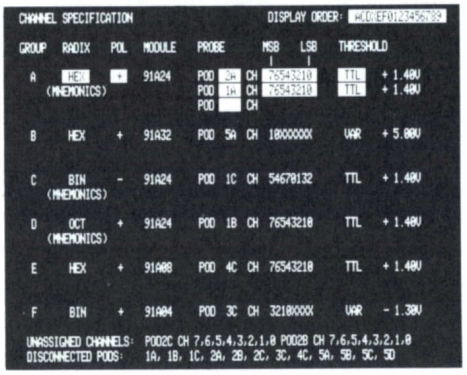
The Leader in Flexibility and Ease of Use Through Superior Human Engineering

Besides color, the DAS 9100 includes many other important human engineering features. Its menu-driven, user interface is easy to learn and self-documenting, so there is no need to constantly refer to manuals. To complement the menu-driven displays, there is a color-coded keyboard organized specifically to enhance user programming. All keys are arranged into logical groups that correspond to the display elements they service.

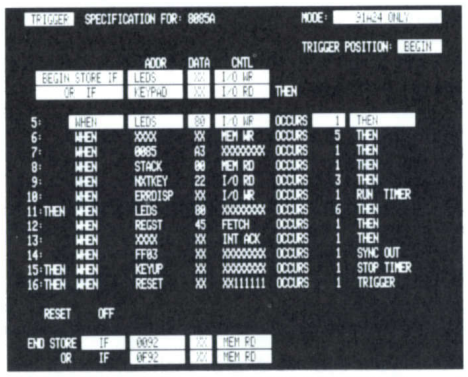




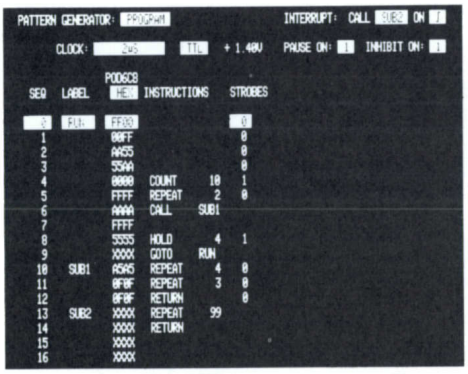
Pull POWER ON: A configuration menu appears describing all card modules in the DAS by slot number location. A sophisticated self-test verification is performed on each module with pass/fail indication. Bottom of screen indicates next step.



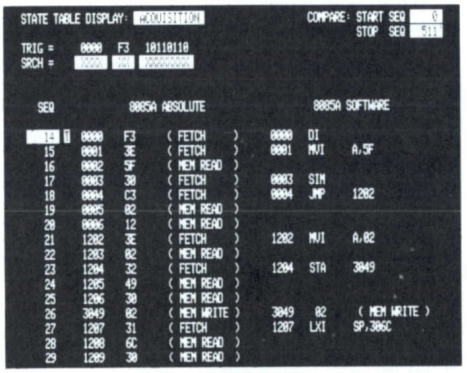
Press CHANNEL SPEC: Through the use of CURSOR and DATA ENTRY keys all data acquisition channels are assigned to groups, a group radix is selected (hex, binary or octal), and individual probe pod thresholds and channel order are user assigned.



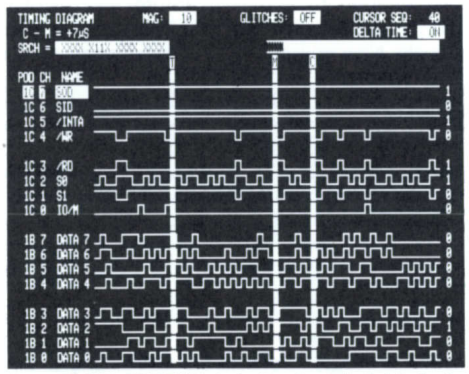
Press TRIGGER SPEC: Use CURSOR SELECT key to scroll through all possible triggering combinations of data acquisition modules, including "ARMS MODE". The 91A24's five word recognizers with 16-level stack are shown. Address and control fields symbolically display labels and control functions.



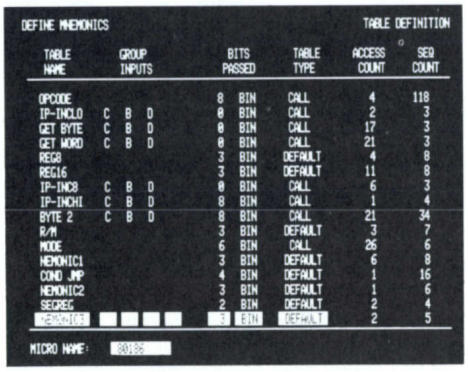
Press PATTERN GENERATOR: This menu allows you to construct a pattern generation program 254 lines deep using English-language like commands. Labels maybe used to identify program segments and can be called from the main program providing sophisticated patterns for the debug of hardware or software.



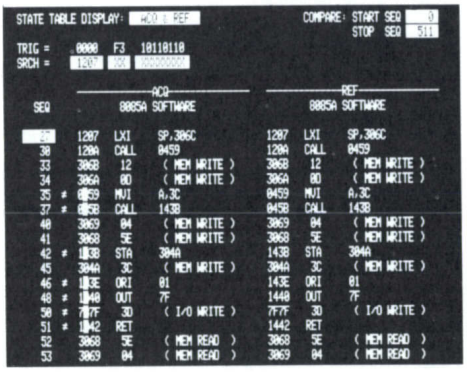
Press START SYSTEM: Data acquisition and pattern generator modules are simultaneously started. When a trigger occurs the DAS immediately defaults to the STATE TABLE format display with the trigger word clearly indicated on screen. Acquisition or pattern generator modules may be started separately by using the START ACQUISITION or START PAT GEN keys.



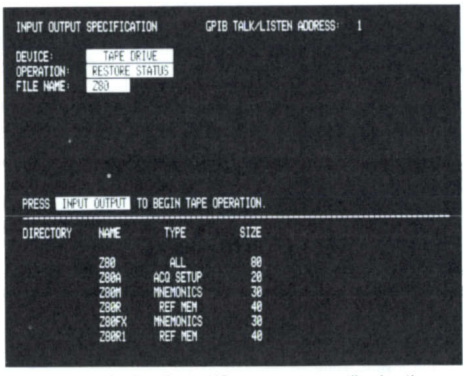
Press TIMING DIAGRAM: Instantly all acquired data is displayed with trigger word clearly indicated. Use SCROLL keys to make DELTA-TIME measurements or CURSOR keys to turn glitches on or off. Select magnification values from X1 to X10,000. Add labels for each channel using DATA ENTRY keys.



Press DEFINE MNEMONICS: Extended Define Mnemonics (EDM) provides complete disassembly capability to the DAS state table display. You can use it to disassemble any type of acquired data, whether from microprocessors, mini-or microcomputer, or buses. EDM is controlled by three submenus accessed via the DEFINE MNEMONICS menu key.



Press STATE TABLE: Reference memory is loaded by pressing STORE. REF MEM may be edited prior to doing an ACQ MEM and REF MEM compare. Display ACQ MEM ONLY, REF MEM ONLY or both by using SELECT key. A SEARCH word may be entered and the search begun by pressing the SEARCH key.



Press INPUT OUTPUT: An I/O menu appears allowing the user to easily store or retrieve instrument setups, reference patterns and mnemonic (EDM) files and to define parameters for GPIB, RS-232, Master/Slave and serial Line Printer operation.

DAS 9100 CHARACTERISTICS

DATA FORMATTING

Group Designations — Up to 16 groups (1 to 32 channels per group).
Display Order — Designate group display order for state table.
Channel Order — Designated channel order within a group.
Radix — Octal, Binary, or Hexadecimal.
Polarity — Positive or negative (complement).
Threshold — Select TTL or variable.

TRIGGERING

Trigger — Synchronous or Asynchronous.
Trigger Word Position — Begin, Center, End of Memory.
Trigger Delay — 1 to 32,767 clock samples.
Trigger Word Display — Hex, Binary, Octal, or mixed radix; any bits allowed as don't care (X).
Trigger Modes (Word Recognition)
Up to five word recognizers with sixteen level stack (module dependent, see individual acquisition module specs)
- External Trigger Enable (TTL)
- Word Recognizer Output (TTL)
- 91A32 arms 91A08 or 91A04A/91AE04A
- 91A24 arms 91A08 or 91A04A/91AE04A
- 91A32 and 91A08
- Compare until equal or not equal

Glitch Recognizer (91A08 only)
- Enable by channel
- OR'ed with 91A08 trigger word

Clocks — See individual module specs.
Clock Qualifiers — See individual module specs.

DATA ACQUISITION DISPLAY MODES

Timing Diagram Features
- Simultaneous display of 16 user selectable channels
- User definable six-character trace labels for each displayed channel
- Data magnification factors from X1 to X10,000
- Cursor position and word readout in binary
- Search word
- Time aligned data display for arming mode
- Glitch display select (91A08 only)
- Horizontal data scrolling
- Memory display window
- Delta time measurement cursors

State Table Features
- Hex, Binary, Octal, or mixed radix
- Definable mnemonics displayed by group in acquisition/reference memory displays
- Search word
- Time-aligned data display for arms mode
- Vertical or block scrolling
- Cursor position
- Up to 1023 bits by 96 channels reference memory display, with or without data acquisition display
- Reference memory editing
- Programmable compare window
- Reference memory mask word capability
- Compare mode — highlighted and flagged for differences

Extended Define Mnemonics
- Software disassembly mode
- Hardware disassembly mode
- Absolute disassembly mode
- Simultaneous display of any two modes
- (Dependent on processor and mode selected)

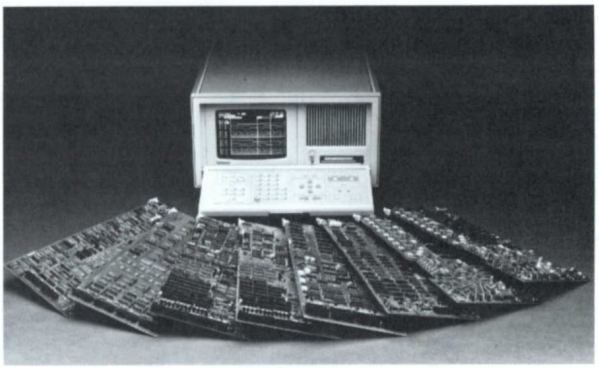
Up to 64 nestable tables with 256 entries per table. More than sufficient to completely disassemble 80186 and 68000 type processors.

KEYBOARD

The DAS 9100 keyboard is divided into four sections for ease of use and functionality. Menu keys, data entry keys, edit and cursor control, and system control keys provide total control at your fingertips.

I/O SUMMARY

DC-100 Tape Drive
Stores 6 full instrument setups or 20 different reference memory patterns. Directory space for 32 files.
RS-232
Selectable Baud Rates: 300, 600, 1200, 2400, 4800, 9600.
Master/Slave Operation: Full Duplex, Asynchronous



GPIB
Talker/Listener Only.
Selectable Address.
Selectable Controller Type, EOI or (LF or EO1).
Line Printer Output (Option 06 Only)
Prints both state and timing diagram.
RS-232 serial printers only.
Selectable baud rates to 9600 baud.
Supports CTRL/S and CTRL/Q handshaking.
Composite Video Output
Hardcopy interface.
Video monitor interface.

OTHER CHARACTERISTICS

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	432	17.0
Height	241	9.5
Depth	597	23.5
Weight	**kg**	**lb**
Without Accessories	21.8	48.0

LO Line — 90 V to 132 V RMS.
HI Line — 180 V to 264 V RMS.
Line Frequency — 48 Hz to 63 Hz.
Power — 1000 VA, maximum.
Temperature Range — Operating: 0°C to +50°C (+32°F to +122°F).
Storage: −40°C to +65°C (−40°F to +149°F).
Altitude — Operating: 10,000 ft maximum.
Storage: 50,000 ft. maximum.

ORDERING INFORMATION

DAS 9109 Monochrome Mainframe ... **$5,500**
DAS 9119 ATE Mainframe (Deletes CRT and Keyboard; Adds Option 06) **$6,350**
DAS 9129 Color Mainframe **$8,400**

MAINFRAME OPTIONS

Option 01 — DC-100 Tape Drive ..... **+$1,450**
Option 02 — RS-232C, GPIB and Hardcopy Interface ..... **+$1,150**
Option 03 — Additional Power Supply ..... **+$800**
Option 04 — Two Additional Power Supplies ..... **+$1,600**
Option 05 — Rackmount Hardware ..... **+$200**
Option 06 — High-Speed GPIB, Serial Line Printer Port, Plus Option 02 Features ..... **+$1,550**
Option 88 — Mainframe shipped with modules installed and checked out as part of the mainframe ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro, 220 V/16 A, 50 Hz
Option A2 — UK, 240 V/13 A, 50 Hz
Option A3 — Australian, 240 V/10 A, 50 Hz
Option A4 — North American, 240 V/15 A, 60 Hz
Option A5 — Switzerland, 220 V/10 A, 50 Hz

FIELD INSTALLABLE OPTIONS

DAS 91F1 — Field Installed Option 01 (Includes Installation in Service Center) **$1,700**
DAS 91F2 — Field Installed Option 02 (For Mainframes Below S/N B020100) **$1,300**
DAS 29F2 — Field Installed Option 02 (For Mainframes Above S/N B020100) **$1,300**
DAS 91F6 — Field Installed Option 06 (For Mainframes Below S/N B020100) **$1,700**
Option 01 — Field Installed Option 06 (For Mainframes Above S/N B020100) ..... **NC**

MODULES

The following module prices do not include probes. Please order probes separately. See probe selection guide at end of this order section and pages (84 through 87) for additional module and probe selection information. Maximum of 6 modules per mainframe and 104 data acquisition channels.

91A04A — Data Acquisition Module **$6,390**
91AE04A — Data Acquisition Expansion Module **$4,390**
91A08 — Data Acquisition Module (One P6454 Clock Probe Required Per DAS Mainframe for Synchronous Operation) **$3,255**
91A24 — Data Acquisition Module **$2,890**
91AE24 — Data Acquisition Expansion Module **$2,600**
91A32 — Data Acquisition Module **$2,070**
91P16 — Pattern Generator Module **$2,840**
91P32 — Pattern Generator Expansion Module **$4,600**

Note: When adding modules, check that the correct number of power supplies are also selected. The mainframe includes sufficient power for two modules. One additional power supply (Option 03) is required for three or four modules. Two additional power supplies (Option 04) are required for a total of five or six modules.

Microprocessor/Bus support: For ordering information please see pages 82 and 83 .

PROBES

P6452 — Eight Channel Data Acquisition Probe **$730**
P6453 — Four Channel High-Speed Data Acquisition Probe **$1,560**
P6454 — External Clock Probe For 91A08 Modules (Only One Required) **$265**
P6455 — Eight Channel TTL/MOS Pattern Generator Probe **$575**
P6456 — Eight Channel ECL Pattern Generator Probe **$575**
P6457 — Four Channel Tri-State Pattern Generator Probe **$575**
P6460 — Eight Channel Data Acquisition Probe **$700**
P6462 — Eight Channel TTL Only Data Acquisition Probe **$340**

PROBE SELECTION GUIDE

DAS Module	No. Probes Required	Recommended Probe	Special Purpose Probes
91A04A	1	P6453	
91AE04A	1	P6453	
91A08	1	P6452	P6454
91A24	3	P6460	P6462
91AE24	3	P6460	P6462
91A32	4	P6452	P6462
91P16	2	P6455	P6456, P6457
91P32	4	P6455	P6456, P6457

OPTIONAL ACCESSORIES

Additional Power Supply — Order 020-0707-00 ..... **$800**
DAS Setup and Hold Calibration Fixture — Order 067-1037-00 ..... **$1,200**
High Speed Acquisition Test Fixture for 91A04A — Order 067-1139-00 ..... **$250**
For additional accessories please see pages 84 thru 87.

NEW

LOGIC ANALYZERS

GPIB IEEE-488 1240

The 1240 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Total Design Support: Hardware, Software, and Integration

Up to 72 Acquisition Channels

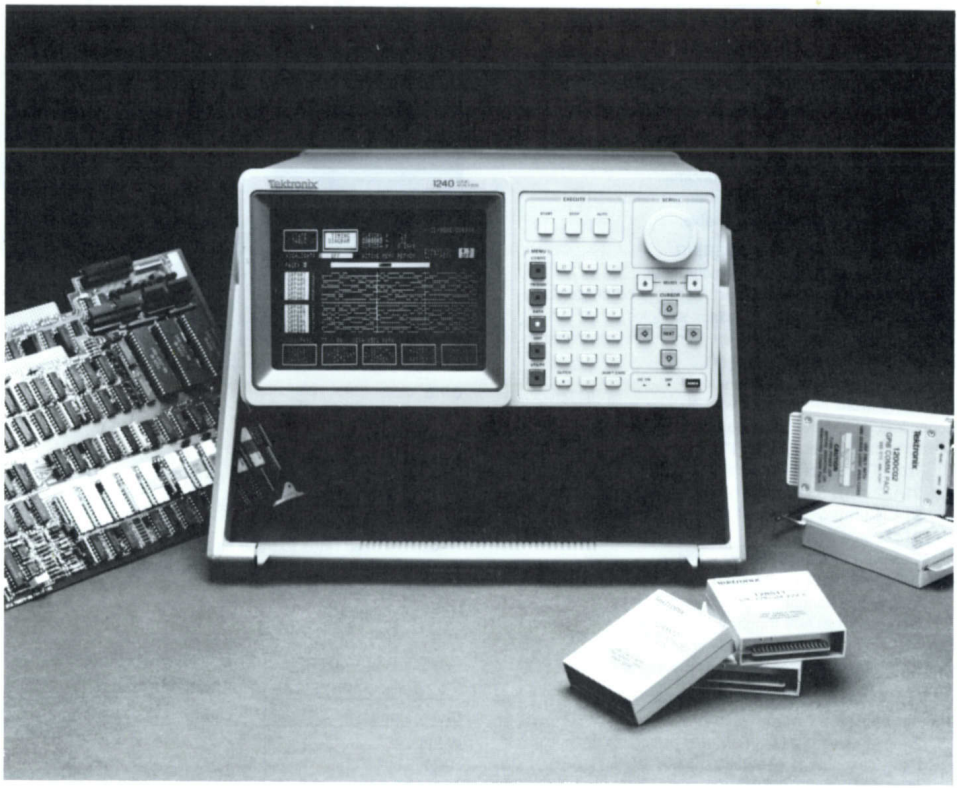
Acquisition Speeds to 100 MHz Async, 50 MHz Sync

Single Probe Demultiplexing

Dual Timebase Triggering, Acquisition and Display

Simple Menu Operation With On-Screen Soft Keys

Transfers Easily into Manufacturing and Service



TOTAL PERFORMANCE

With the new 1240 Logic Analyzer, the key phrase is **total performance.** This one instrument provides complete support for all aspects of the design task, including hardware analysis, software analysis, and integration.

Hardware Analysis

For hardware analysis, the 1240 offers up to 36 channels of acquisition at sampling rates of 100 MHz asynchronous and 50 MHz synchronous (see acquisition card descriptions). 6 ns glitch detection is also available.

Standard memory depth is 512 bits per channel, and this can be extended to a maximum of 2048 bits per channel by using a special memory chaining feature. This feature allows you to chain one card's memory to another, trading channel width for memory depth.

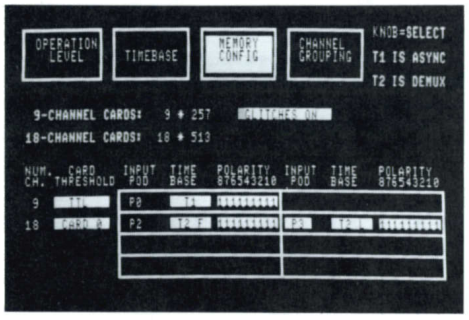


Figure 1. Memory Configuration Menu.

Superior hardware triggering capabilities include data and glitch triggering for isolating the problem area; clocked and unclocked triggering for capturing events that might not coincide with sample points; and counters, timers, and duration filters for triggering on the characteristics of a signal as well as its occurrence.

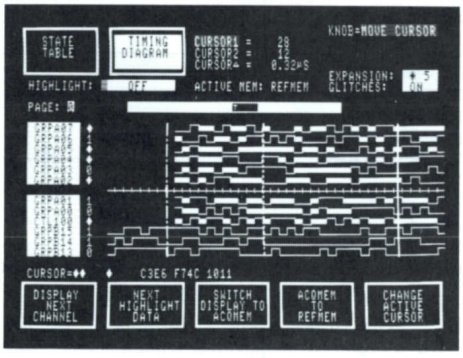


Figure 2. Timing Diagram With Glitches.

Auto-run capability is also provided. This feature allows you to track intermittents through continuous acquisitions. During the acquisitions, you can change parameters on the system under test and dynamically monitor their effects.

Software Analysis

Software analysis is supported by up to 72 data channels at sampling rates of 50 MHz synchronous/asynchronous (see acquisition card descriptions). A flexible clocking scheme includes data demultiplexing without double-probing.

Powerful software triggering capabilities are provided so you can track program flow. Included are 14 trigger levels, conditional branching, counters, timers, and data and storage qualification. These functions are implemented in two independent event recognizers.

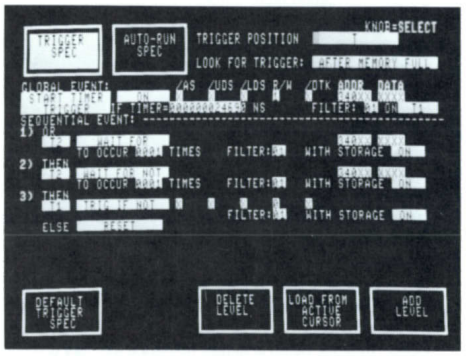


Figure 3. Trigger Specification Menu.

Other features that assist in software analysis are flexible channel groupings for display, standard display radices (including ASCII and EBCDIC), and an 8-level pattern search and memory compare with highlighting.

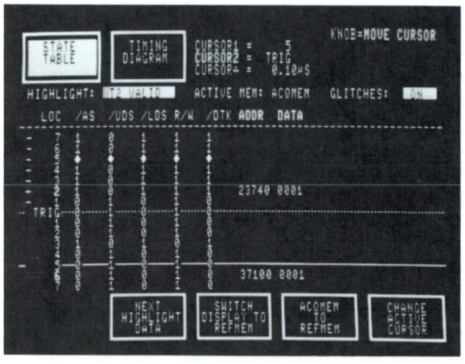


Figure 4. State Table Display.

Hardware/Software Integration

For integration, the 1240 offers a dual timebase system that brings together all of the above hardware and software analysis capabilities. This dual timebase system greatly speeds the hardware/software integration process since the acquisition, triggering, and display of two independent timebases are tied together. You can fully monitor the interaction between hardware and software, or monitor the relationship of two independent systems. All data displays are time-aligned and completely correlated. The dual timebase allows you to integrate functional modules, an increasingly important design task.

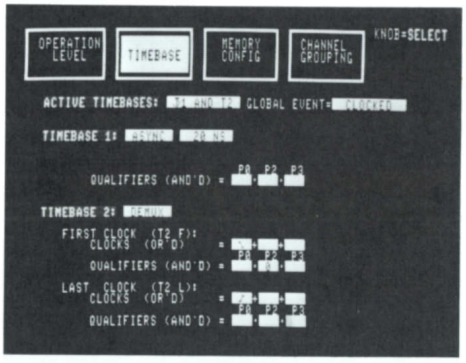


Figure 5. Timebase Menu.

FLEXIBILITY NOW AND IN THE FUTURE

The power of the 1240 stems from its configurable mainframe. This mainframe houses a selection of data acquisition cards and plug-in ROM and COMM Packs. You can select features that meet your current application needs, then later upgrade the mainframe to increased performance.

Selectable Acquisition Cards

The 1240 mainframe provides four card slots that accommodate any combination of the following card types: 1240D1 and 1240D2.

The 1240D1 is a 9-channel data acquisition card that can sample at rates up to 100 MHz asynchronous and 50 MHz synchronous. This card also provides glitch capture down to 6 ns.

The 1240D2 card is an 18-channel data acquisition card that can sample at rates up to 50 MHz asynchronous/synchronous. Another feature of this card is single-probe demultiplexing.

ROM Packs for Data Processing

A ROM port on the side of the 1240 mainframe supports the addition of special software ROM Packs. Currently, there are ROM Packs supporting performance analysis and mnemonic disassembly of popular microprocessors and (see page 72).

COMM Packs for External Communications

Communication capabilities can be added to the 1240 by inserting COMM Packs into a communications port on the rear of the instrument. These COMM Packs act as adaptors, allowing the 1240 to function in different communication environments, including RS-232C and GPIB (see page 73).

On-Going Support

With the 1240, you not only get optimum performance for the price, but also reduce the chances of equipment obsolescence. Tek's on-going development of hardware and software add-ons will keep the 1240 state-of-the-art for years to come.

EASE OF USE

In line with Tek's goal of easy-to-use logic analyzers, the 1240 human interface has been designed to facilitate the user's operation of the instrument.

Menu Operation and Soft Keys

Ease of use starts with the 1240's menu operating system. Straightforward menu displays and on-screen soft keys allow you to make setup choices on the screen where your attention is already directed. You are not distracted by the need to look elsewhere on the instrument.

Another major feature of the menu operating system is user-selected operation levels. The 1240 provides four operation levels, ranging from basic operation for simple applications to full operation for complex applications. The sophistication of system features increases with the operation levels.

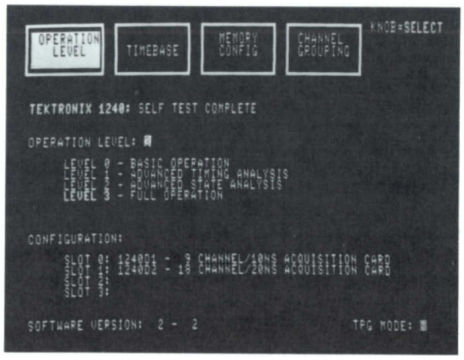


Figure 6. Operation Level Menu.

Configurable From the Front Panel

The 1240 is completely configurable from the front panel, thus eliminating the need to switch boards and reconnect probes when changing from hardware to software applications. Probe connections are on the side of the instrument so they can be easily accessed. The keyboard has a simple layout, with single function keys. Also, a knob is included on the keyboard for data scrolling. This knob, along with the extreme smoothness of the data scrolling, make the 1240 displays easier to read and manipulate.

Automatic Non-volatile Storage

A battery-backed CMOS memory stores two complete instrument setups, including the last setup used before the 1240 is powered down. This facilitates quick instrument start-up when returning to work, and eliminates the problem of losing a setup as a result of power system interruptions.

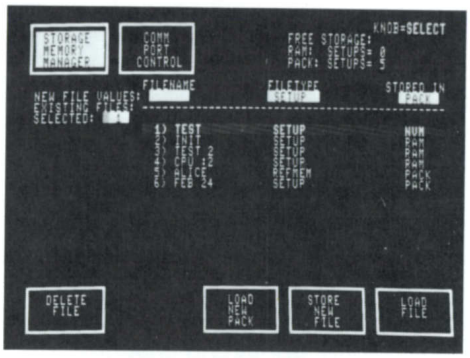


Figure 7. Storage Memory Manager Menu.

IDEALLY SUITED FOR ENGINEERING, MANUFACTURING, AND SERVICE

In addition to its usefulness in the engineering environment, the 1240 is well suited for manufacturing and service tasks. It transfers easily from one environment to another and helps facilitate communications between the different groups through its portability, remote control, and mass storage capabilities.

Portability

The 1240 weighs 26.5 lb and meets environmental Class III specifications. This makes it an ideal choice for a rugged logic analyzer that can be used in many locations.

Remote Control

RS-232C and GPIB COMM Packs (see page 73), are ideally suited to automated test environments and remote control.

Mass Storage

Mass storage of setups, acquisition memories, and reference memories is achieved through RAM and EPROM Packs. This type of pack storage allows engineering to easily transfer knowledge to other groups. They can create the setups and memories needed for design test in manufacturing, or they can create servicing procedures at the factory that can be sent out to field service sites.

Two types of pack storage are available. First, there is the 12RS01 8K RAM Pack. This pack can store up to eight setups or a combination of memories and setups. Storage and retrieval of information from this RAM Pack is accomplished via menu soft keys (see Figure 7).

The 12RS11 32K EPROM Pack (no EPROM included) and the 12RS12 32K EPROM (EPROM included) provide a permanent storage medium for setups and memories. To store files on these EPROM Packs, the setups and memories are uploaded from the 1240 to a host via GPIB or RS-232C, and then burned into EPROMs.

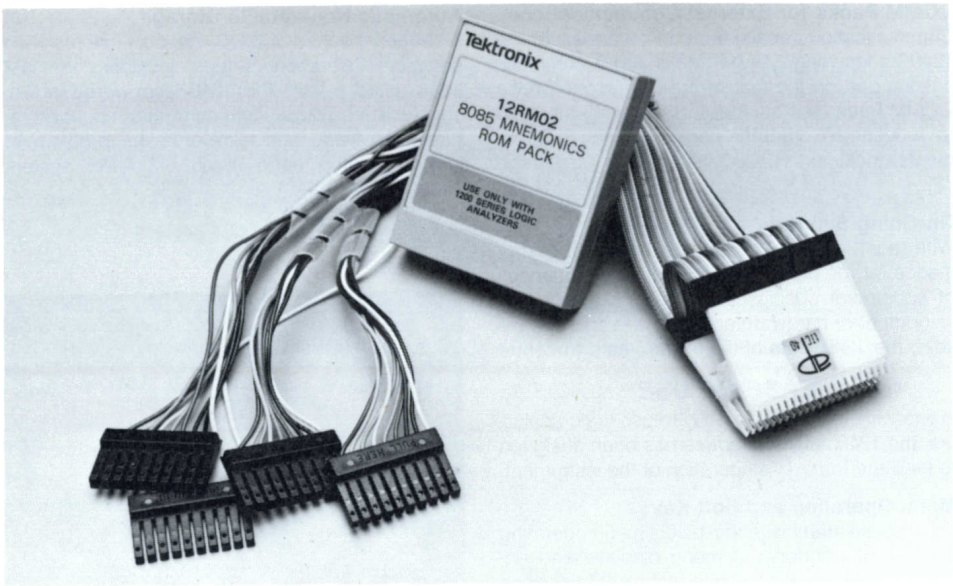


Figure 8. 12RM02 8085 Mnemonics ROM Pack with 8085 Probe Interface.

MICROPROCESSOR SUPPORT

The 1240 provides microprocessor support for all major 8- and 16-bit processors. This support is a turnkey solution that includes a single plug interface, data acquisition capability and mnemonic disassembly.

The microprocessor support is provided for the 1240 in the form of Mnemonics ROM Packs (12RMXXs), with one ROM Pack for each microprocessor.

For 8-bit and simple 16-bit processors, the 1240 uses its powerful general purpose clocking and demultiplexing capabilities to acquire the data. Two 1240D2 cards using standard data acquisition probes (P6460 or P6462) are attached to the processor via a probe interface which connects the probes to a dip clip that fastens directly onto the microprocessor. (See Figure 8). Three 1240D2 cards are required for the simple 16-bit processors. The probe interfaces are preconfigured for each processor the 1240 supports.

For 16-bit processors, the 1240 uses the PM 200 Series of personality modules to acquire the data for disassembly by the 12RMXX. These modules provide the special purpose hardware needed to properly acquire the instruction flow from a prefetch processor architecture and its associated internal queue (see Microprocessor Support section for more information). These modules plug directly into the 1240D2 cards, replacing the general purpose data acquisition probes and providing the interface to the processor. Three 1240D2 cards are required for 16-bit processors.

Four disassembly formats are available for viewing the data after disassembly: State, Absolute, Hardware, Software.

State format is exactly the same as standard State Table format.

Absolute format augments the State format with cycle operation labels (FETCH, WRITE, etc.).

Hardware format provides disassembly information (instructions or cycle labels) on all acquired cycles. (See Figure 9).

Software format is similar to Hardware disassembly format with the display of instruction read cycles which are not opcode fetches suppressed.

The processors that are currently supported by the 1240 are:

6502/65C02	8080	NSC800
	8085	
6800	8086	Z80
6802	8088	Z8001
6808	80186	Z8002
6809	80188	
68000		
68008	F9450	

For ordering information, please refer to the Microprocessor Support section on page 82.

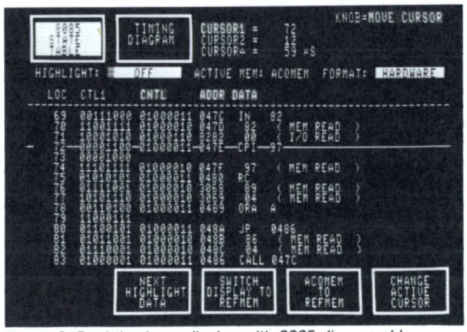


Figure 9. Dual-timebase display with 8085 disassembly.

PERFORMANCE ANALYSIS

Performance analysis is a tool that assists software engineers in the development of microprocessor-based products. It can be used throughout the life cycle of a product to help the designer characterize, test, debug, and optimize software.

The real benefit of performance analysis over other types of software development tools is that it provides non-intrusive overview measurements of software performance. In other words, it can be used to improve efficiency by providing measurements that characterize performance without altering the software.

Two types of performance analysis (Range Postprocessing and Event Measurement) are available for the 1240 in the 12R01 Performance Analysis ROM Pack. (See Figure 10). These two types of analysis provide overviews of the activity of the system under test, graphically displaying this activity in the form of histograms.

Range Postprocessing

With range postprocessing, the user can define up to eleven ranges-of-values on any previously defined data groups. The 1240 takes successive acquisitions and processes each location of each acquisition to see if each group's value at that location falls into the ranges defined for it. A cumulative count is kept of the number of locations falling into the defined range and is reported as a total count, a percentage of the total number of locations counted for the timebase of the group, and as a histogram bar (proportional in length to the percentage). (See Figure 11).

Event Measurement

In this type of analysis between one and four "events" are defined by the user for measurement. An "event" consists of a sample window and a target event. The window has two parts: an "open" event (when found, marks the beginning in time of the sample window) and a "close" event (marks the end in time of the sample window). While the window is open, occurrences of the target event are counted or timed.

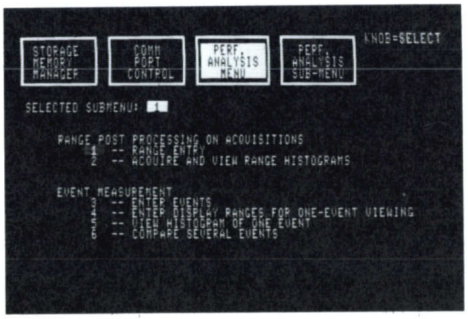


Figure 10. Performance Analysis Menu.

The distribution of the sample measurement is reported in histogram form with user-selectable scaling. When several events are being measured, the following statistics on their distributions can be compared: cumulative mean, minimum value, and maximum value.

Performance Analysis can be used for both hardware and software applications. As an example of a software application, event measurement may be used to determine the distribution of execution times of an interrupt processing routine. The average amount of time, and the minimum and maximum execution times can also be displayed.

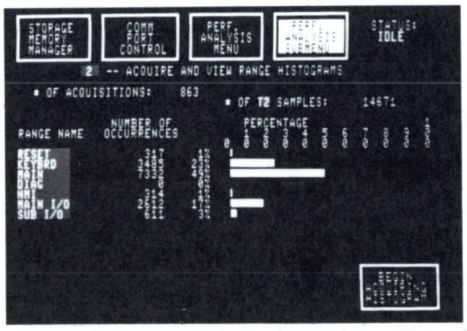


Figure 11. Performance Analysis sub-menu for acquiring and viewing range histograms.

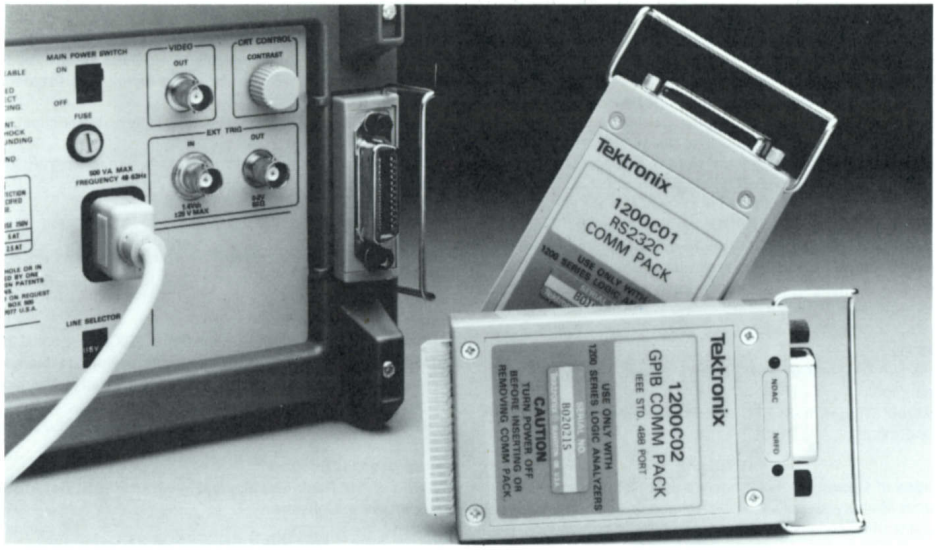


Figure 12.1240 with COMM Pack inserted

1240 EXTERNAL COMMUNICATIONS

External communication capability is supported in the 1240 by means of modular COMM Packs. These COMM Packs, which plug into a COMM port on the back of the 1240 (see figure 12), provide flexibility in interfacing the 1240 to other equipment.

REMOTE CONTROL

Two COMM Packs are provided to interface the 1240 to controllers, the 1200C01 RS-232C COMM Pack and the 1200C02 GPIB COMM Pack. The 1200C02 interface conforms to IEEE specification 488-1978, Standard Digital Interface for Programmable Instrumentation.

You can remotely control all of the capabilities of the 1240 using these COMM Packs.

The controller can start and stop data acquisitions and the auto-run function, write to the display, define custom soft keys, request 1240 keystrokes, initiate 1240 diagnostics, and request diagnostic results. Instrument setups, acquisition memories, reference memories and RAM Pack contents can be sent and received from the 1240, also.

Requests from the 1240 to upload and download setups and memories are initiated via soft keys (see figure 13).

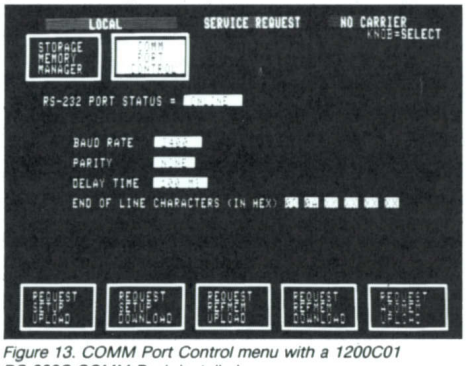


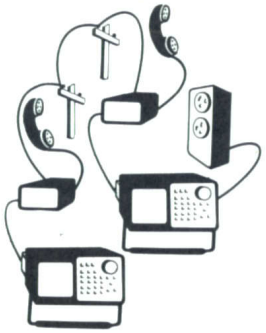
Figure 13. COMM Port Control menu with a 1200C01 RS-232C COMM Pack installed.

The 1200C02 GPIB COMM Pack interface conforms to IEEE specification 488-1978, Standard Digital Interface for Programmable Instrumentation. The 1240 operates via the GPIB COMM Pack with controllers such as the Tek 4041, 4051, 4052, 4052A, 4054 and 4054A.

VIDEO OUT

The 1240 comes equipped with an RS-170-compatible composite video signal of the current screen display.

MASTER/SLAVE SUPPORT



Master/Slave support is provided so that one 1240 (designated as Master) can completely control a remote 1240 (designated as Slave).

The 1240 supports master/slave operation with the following configuration in each of the 1240's: a 12RC02 Master/Slave ROM Pack, a 1200C01 RS-232C COMM Pack and a user-supplied modem.

The following operations are available to the user: send and receive setups, acquisition memories and reference memories, start acquisitions, start auto-acquisitions and receive information on whether the memories were equal or not equal after auto-acquiring. Diagnostic operations on the link between the two 1240s are available at any time.

PRINTER SUPPORT

Through the use of a ROM Pack and COMM Pack combination the 1240 is able to print hard copies of setup menus and data acquisition memories. Support will be provided for almost all commercially available low-cost printers. (See figure 14).

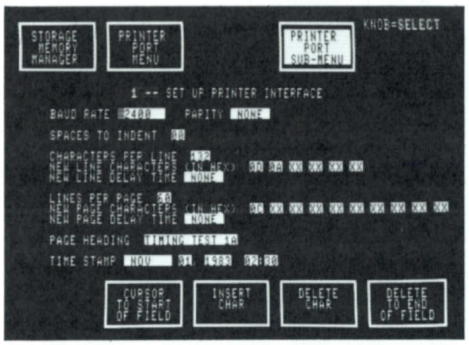


Figure 14. Printer Port sub-menu for setting up printer interface parameters.

The printer interface consists of the combination of a ROM Pack and a COMM Pack. The 12RC01 Printer Support ROM Pack is used in combination with either the 1200C01 RS-232C COMM Pack (for printers with a serial interface) or the 1200C11 Parallel Printer COMM Pack (for printers with a parallel interface).

You can output any of the information in the set-up menus, the entire contents (or user-selectable portions) of acquisition or reference memory in state table or timing diagram format (see figure 15), the search pattern or you can utilize a screen print mode.

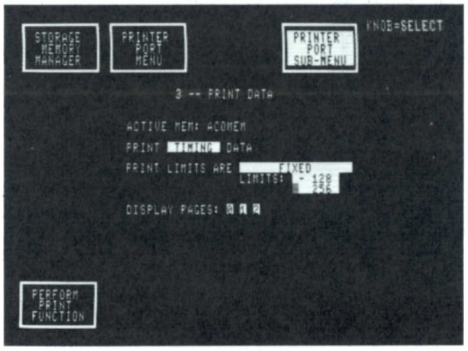


Figure 15. Printer Port sub-menu for printing timing diagrams.

1240 EXTERNAL COMMUNICATION SUPPORT

To equip the 1240 for one of the three types of communications support shown across the top of this table. Choose one of the combinations of ROM Pack and COMM Pack whose intersection is indicated by XXXX's. Performance varies depending on the combination of packs that you select for a particular kind of support.

	Remote Control	Printer Support	Master/ Slave Support
ROM Packs	None Required	12RC01 Printer Support	12RC02 Master/ Slave
COMM Packs			
1200C01 RS-232C	XXXX	XXXX	XXXX
1200C02 GPIB	XXXX		
1200C11 Parallel Printer		XXXX	

NEW

LOGIC ANALYZERS

CHARACTERISTICS

OPERATING LEVELS

Level 0 — Basic Operation.
Level 1 — Advanced timing analysis (includes basic state analysis).
Level 2 — Advanced state analysis (includes basic timing analysis).
Level 3 — Full operation.

TIMEBASES

Two per instrument—assignable by probe.
Timebase 1: Asynchronous or Synchronous.
Timebase 2: Synchronous or Demultiplex.

INPUTS

Clocks — C1, C2, . . . Cn. Where n = number of probes = number of channels/9. Minimum pulse width: 8 ns. Specifiable as rising, falling, or either edge.
Qualifiers — Q1, Q2, . . . Qn. Where n = number of probes = number of channels/9. Setup Time, Hold Time: 10 ns, 0 ns. Specifiable as high or low level.
Asynchronous — Rate: 10 ns to 1 s (20 ns to 1 s on 1240D2). Specification: (1-2-5 sequence) • (Q1 • Q2 • . . . • Qn). Accuracy: 01%. Channel to Channel Skew: ±3 ns. Glitch Detection: 6 ns (on 1240D1 only).
Synchronous — Rate: Dc to 50 MHz. Setup Time, Hold Time: 7 ns, 1 ns (12 ns, 0 ns on 1240D2). Specification: (C1 + C2 + . . . +Cn) • (Q1 • Q2• . . . • Qn). Minimum delay after previous clock: 20 ns.
Demultiplex — Rate: Dc to 33 MHz. Setup Time, Hold Time: 10 ns, 0 ns. Specification: First Phase Clock (Latch Data) (C1 + C2 + . . . + Cn) • (Q1 • Q2 • . . . • Qn). Minimum delay after last phase clock: 20 ns. Last Phase Clock (Store Data) (C1 + C2 + . . . + Cn) • (Q1 • Q2 • . . . • Qn). Minimum delay after first phase clock: 10 ns.

CONFIGURABILITY

Two types of acquisition cards: 1240D1, 1240D2.
Maximum of four cards per 1240, in any combination.

	1240D1	1240D2
Number of Channels	9	18
Asynchronous Rate With glitches	100 MHz 50 MHz	50 MHz N/A
Synchronous Rate	50 MHz	50 MHz
Memory Depth (bits/Char channel With Glitches	512 256	512 N/A
Max Via Chaining	2048	2048

Depth vs Channels — Tradeoffs possible between data acquisition cards of same type. Maximum depth is 2048 (with four 1240D1 or four 1240D2).

DATA ACQUISITION

Two Types of Acquistion Probes: P6460, P6462.
One probe required per 1240D1, two per 1240D2.

	P6460	P6462
Signal Input Data Channels Clock/ Clock Qualifier Lines	 9 1	 9 1
Impedence Nominal Threshold Range Increments Accuracy Threshold Assignment Polarity Assignment	 1 MΩ, 5 pF −6.35 V to 6.35 V 0.05 V ±0.5% ±0.065 V By acquisition card By channel	 ≈1 LTTL 1.4 V — ±.25 V +.055 V/(°C −25°C) N/A By channel
Maximum Input Voltage Peak Channel to Channel	 ±40 V ±60 V	 −2 to +7 V No restriction

NOTE: All system specifications are based upon P6460 probes, for specifications based upon P6462 probes, please refer to the 1240 Data Sheet.

TRIGGER DEFINITION (TWO EVENT RECOGNIZERS)

Global Event Recognizer (Event Recognizer #1) — One level. Event Recognition specified by: Word recognizer—data (data or glitch on 1240D1). Duration filter—1 to 16 consecutive samples or 10 ns to 160 ns. Commands: Store On (Not), Trigger On (Not), Reset On (Not), Start Timer On (Not), Time While On (Not), Increment Counter On (Not), or Off.
Counter/timer: Clock interval is 10 ns. Range is 0 to 99,999,999,999 (either counts or 10 ns increments) Counter/timer value may be used to cause trigger or reset.
Sequential Event Recognizer (Event Recognizer #2) — 14 levels. Event Recognition on each level specified by: Timebase: Which timebase to monitor for event. Word Recognizer: Data (data or glitch on 1240D1). Iteration Counter: 1 to 9999 occurances. Duration Filter: 1 to 16 consecutive samples. Selective Storage on each level specifiable: With Storage On or with Storage Off. Commands on each level: Wait For (Not), Trigger If (Not), Reset If (Not), Jump If (Not) or Delay (up to 9999). Commands at end of sequence: Trigger, Reset or Do Nothing.
External Trigger Out — TTL level output whenever trigger attempted.
External Trigger In — TTL level input can be required for enabling trigger.

AUTORUN

Modes of Operation — Compare Acquisition Memory to Reference Memory: Specifiable which channels to compare, specifiable starting and ending memory locations of comparison. Result of comparison outcome: Specifiable display and reacquire, discard and reacquire, or display and stop. Specifiable minimum display time: 0 to 99 seconds.
Continuous Trigger Out — Data is not stored. 1240 acts as trigger source.
Trigger In — Requires trigger in signal to enable trigger. Enables two 1240s to work in parallel.
Store After Trigger — Data at last trigger is available after stopping 1240. Time between storages is minimum.

DISPLAY FORMATS

State Table — Acquisition or reference memory. Data displayed in binary, octal, hex, ASCII, EBCDIC. Glitch display can be turned on or off.
Timing Diagram — Acquisition or reference memory. Expansion factors of *1, *2, *5, *10, *20. Glitch display.
Distance Between Cursors — Value displayed as absolute time for unqualified asynchronous measurement, as number of memory locations for qualified or synchronous measurement.
Highlighting Modes — Memory comparison differences, glitches, search pattern occurences, timebase #1 occurences, timebase #2 occurrences.
Search Pattern — Length: 1 to 8 contiguous locations. Timebases: Can restrict each location to occur only on T1, T2 or T1 and T2.

STORAGE

Internal (Standard)
Nonvolatile Memory (NVM) — Size: Contains two set-ups, including status at power down, lithium iodide battery.
Volatile Memory (RAM) — Size: Contains two set-ups.
External (Optional)
RAM Pack (12RS01) — Size: Contains 8K bytes, lithium iodide battery.
EPROM Packs (12RS11, 12RS12) — Size: Contains 32K bytes.
Memory Types
Set-Up — Stored in NVM, RAM, or Pack, contains all data pertinent to making an acquisition.
Reference Memory — Stored in Pack, reference memory is editable in Edit Reference Memory menu.

OTHER CHARACTERISTICS

Diagnostics — At power-up, the 1240 performs processor, ROM, RAM and board checks. A test pattern generator located on the side of the 1240 provides stimulus for verifying probes and acquisition system operation. Complete system verification and extended diagnostics are available with an optional ROM Pack.
Rear Panel Connections — Trigger In: TTL compatible. Trigger Out: TTL compatible. Video Out: Confroms with RS-170 (composite video).
Power — 90 V to 132 V or 180 V to 250 V. 48 Hz to 440 Hz.

ENVIRONMENTAL CHARACTERISTICS

Temperature — Operating: −15°C to +55°C with up to two acquisition cards; −15°C to +50°C with three or more acquisition cards.
Altitude — Operating: Sea Level to 4.6 km (15,000 ft). Storage: Sea Level to 15.0 km (50,000 ft).
Vibration — 0.025 inch displacement. 10 Hz to 55 Hz frequency range.
Shock — 30 g.

COMM PACKS

1200C01 (RS-232C to a Controller) — Baud Rate: 110 to 9600. Bits/Character: Eight, including parity bit. Protocol: Asynchronous full duplex.
1200C02 (GPIB to a Controller) — Full listener/talker capabilities, meets IEEE-488 (1978).
1200C11 (Parallel Interface to Printer) — Requires: 12RC01 Printer Support ROM Pack.

ROM PACKS

Analysis
12R01 (Performance Analysis) — Range Post-Processing: 1 to 11 ranges. Event Measurement: 1 to 4 events. Includes Histogram Display.
Communication Interface
12RC01 (Printer Support) — Requires: 1200C01 for serial interface or 1200C11 for parallel interface. Output: Menus, search pattern, acquisition and reference memory. Memory Format: Both state table and timing diagram.
12RC02 (Master/Slave Support) — Requires: 1200C01 with user-supplied Modem.
Microprocessor Support
12RMXX (ROM Pack Mnemonics) — Formats: State, Absolute, Hardware, Software.

INCLUDED ACCESSORIES

Accessory pouch (016-0707-00); front panel cover (200-2780-00); operator's manual; 5 reference guides.

ORDERING INFORMATION

1240 Logic Analyzer Mainframe **$4,500**

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

OPTIONAL ACCESSORIES

ACQUISITION CARDS

1240D1 — 9-Channel Data Acquisition Card, 100 MHz, requires one data acquisition probe **$2,250**
1240D2 — 18-Channel Data Acquisition Card, 50 MHz, requires two data acquisition probes **$2,300**

DATA ACQUISITION PROBES

P6460 — 9-Channel Data Acquisiton Probe **$700**
P6462 — 9-Channel Data Acquisiton Probe, fixed threshold TTL **$340**

COMMUNICATION INTERFACES (COMM PACKS)

1200C01 — RS-232C COMM Pack **$750**
1200C02 — GPIB COMM Pack **$850**
1200C11 — Parallel Printer COMM Pack **$500**
Note: To order cables for these COMM Packs, see the Logic Analyzer's Accessories Section.

ROM PACKS

Analysis
12R01 — Performance Analysis ROM Pack **$800**
Communication Functions
12RC01 — Printer Support ROM Pack **$300**
12RC02 — Master/Slave ROM Pack **$500**
Storage
12RS01 — 8K RAM Pack **$300**
12RS11 — 32K EPROM PACK (Empty) **$85**
12RS12 — 32K EPROM PACK **$300**

SERVICE ACCESSORIES

12RD01 — Diagnostic ROM Pack **$1,500**
Diagnostic Lead Set — Order 012-0556-00 ..... **$50**
Extender Card — Order 670-7539-01 ..... **$400**
Service Manual
Service Maintenance Kit — Includes the above Service accessories. Order 067-1103-01 ..... **$2,000**

308

Four Analyzers in One

Up to 25 Channels of Word Recognition Triggering

Ultra-Portable

Easy to Use

Cost Effective

The 308 is a 20 MHz portable analyzer containing a unique combination of features. It provides timing, state, serial, and signature analysis in an extremely easy-to-use package.

CHARACTERISTICS

SIGNAL INPUTS

Timing and State — Multi-line probe-tip, eight data lines, one clock and one ground lead.

Maximum Number of Inputs: Eight.

Input Impedance: 1 MΩ, 5 pF.

Logic Swing —

Minimum: 500 mV +2% of threshold voltage, p-p, centered on threshold voltage.

Maximum: Threshold +10 V to Threshold −15 V.

Maximum Nondestruct Input Voltage: ±40 V.

Width of Data Input: 10 ns minimum with 400 mV overdrive from threshold voltage.

Threshold Voltage: +1.4 V ±0.2 V selectable TTL, −12 V to +12 V variable.

Input Mode: Selectable sample or latch (to 5 ns with 550 mV overdrive voltage).

Serial —

Single Channel Probe Input: 10 MΩ, 13 pF input impedance. 500 V maximum nondestructive input voltage at probe tip. 250 peak at BNC input connector.

Logic Swing: 500 mV minimum + 2% of threshold voltage, p-p, centered about the threshold. ±30 V maximum.

Selectable Parity: ODD, EVEN or NONE.

Selectable Bits Per Character: 5, 6, 7 or 8 bits (includes parity if active).

Selectable Input Logic: Positive or negative (at probe tip).

Synchronizing Word (Synchronous Mode Only): Programmable to require two equal words. If not programmed, defaults to ASCII word SYN.

Hunt Word (Synchronous Mode Only): Programmable to require one word. If not programmed, defaults to "XXXXXXXX" (not defined). One Hunt word is equal to three Hexadecimal "FF"s (line idles).

Stop Bits (Asynchronous Mode Only): Responds to one or more bits.

Signature Analyzer — Single Channel Data Input Via Probe: 10 MΩ, 13 pF clock start and stop inputs provided by data acquisition probe.

CLOCK

Timing and State —

External Clock: 50 ns minimum period. 24.5 ns high-logic level minimum pulse width. 24.5 ns low-logic level minimum pulse width. 25 ns minimum data setup time. 0 ns minimum data hold time.

Internal Clock: 20 MHz sample interval (50 ns minimum). Data pulse width of 1 sample interval +10 ns required to insure sampling minimum. Sample intervals of 50 ns to 200 ms/sample in 1, 2, 5 sequence.

Qualifier Input: Selectable trigger or clock.
+1.4 V ±0.2 V TTL input threshold.
−5 V to +10 V maximum input voltage.

Serial

Synchronous or Asynchronous.

Internal Clock for Asynchronous Mode Selectable Via Keyboard: 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, and 9600 bits/second (baud rate).

Internal Clock Accuracy: ±0.02%.

External Clock for Asynchronous Mode: Up to 9600 baud.

External Clock for Synchronous Mode: Up to 9600 baud.

MEMORY

Data Acquisition Memory — 8 x 252 bits.

Reference Memory — 8 x 252 bits.

Triggering (State and Timing) —

Synchronous or asynchronous.
External qualifier.
Data Word Recognizer: 8 channels, programmable in hex, binary, octal, or decimal.

External Word Recognizer Probe: 16 channels, programmable in hex, binary, octal, or decimal.

Input Threshold: +1.4 V ±0.2 V TTL.

Word Recognizer Out: +1.4 V ±0.2 V TTL.

Trigger Delay: Programmable from 0 to 65,535 clock cycles.

Data Position: Pre- or post-trigger selectable.

First trigger mode (internal select).

Triggering (Serial) —

Data Word Recognizer: Programmable to require a sequence of two words (or characters).

External Trigger: Programmable for one bit (0 or 1).

Trigger Delay: Programmable from 0 to 65,535 by word count (character).

Data Position: Pre- or post-trigger selectable.

Framing Error Detection: Data acquisition is stopped when a valid stop bit is not detected.

DISPLAY

Status information of the 308 is always displayed at the top of the screen. The menu is displayed will all fields visible. In serial mode, an extended menu is provided for additional serial capabilities.

Timing Diagram — Programmable memory window size. Cursor position pointer and word decode. Positive or negative logic display.

State Table — Simultaneous display of hex, binary, and octal. 12 word display table.

Search Mode: Inverse video highlighting.

Compare Mode: Inverse video highlighting of differences.

Positive or negative logic display.

Serial —

Simultaneous display of hex, binary, and ASCII. 12 word character display.

Search Mode: Inverse video display of word.

Compare Mode: Inverse video display of differences.

Positive or negative logic display.

Signature —

Displays the selects for clock, start, and stop. Displays each signature simultaneously. Displays a 4 digit signature.

Displays Character: 0 to 9, A, C, F, H, P, U.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	237	9.3
Heights	117	4.6
Depth	359	13.9
Weights	**kg**	**lb**
Net without probes	3.7	8.0
Net with probes	4.5	10.0

POWER REQUIREMENTS

Line Voltage — 90 V to 132 V ac, 180 V to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Power — 40 W maximum.

Temperature Range — 0°C to 50°C, operating.

INCLUDED ACCESSORIES

Power cord (161-0104-00); accessory pouch (016-0654-00); P6451 probe (016-6451-05); P6107 probe (016-6107-03); operator's manual, maintenance manual.

ORDERING INFORMATION

308 Data Analyzer **$3,950**

Option 01 — P6406 Word Recognizer Probe ..... **+$420**

Option 03 — Extended Signature Analysis Capability (Includes P6406 Word Recognizer Probe) ..... **+$1,950**

1105 Battery Power Supply **$1,430**

Option 01 — 230 V Operation ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK, 240 V/13 A, 50 Hz

Option A3 — Australian, 240 V/10 A, 50 Hz

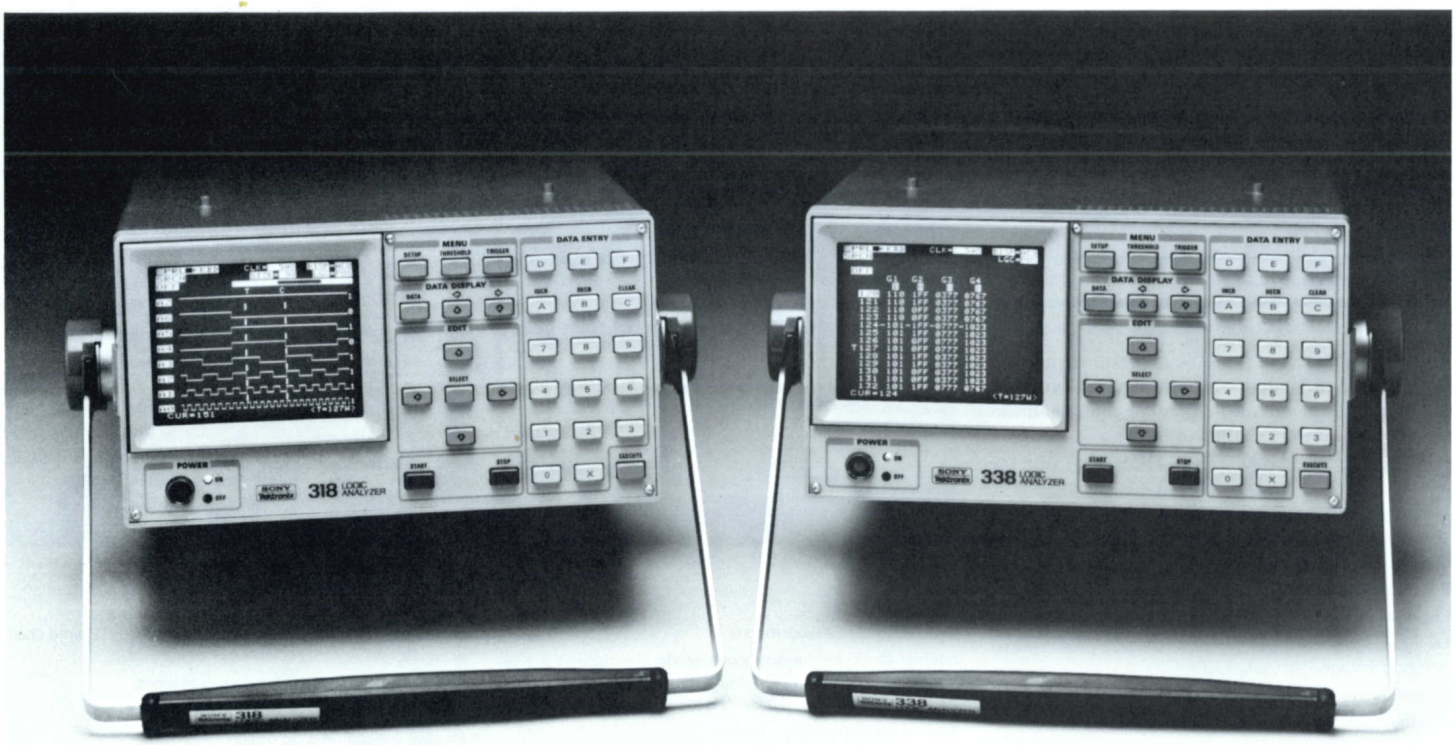
Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

The Sony®/Tektronix® 300 Series is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 300 Series is available from Tektronix, Inc., its marketing subsidiaries and distributors.

NEW

LOGIC ANALYZERS



318/338 Logic Analyzers

Superior Performance/Price Ratio

Both Parallel and Serial Data Acquisition in a Single Instrument

Data Widths to 32 Channels and Acquisition Speeds to 50 MHz

Menu-Driven User Interface for Easy Operation

Powerful Multilevel Triggering

Separate Glitch Trigger and Memory

RS-232 Interface Allows Remote Control

Nonvolatile Memory Retains Both Reference Data and Instrument Setups

Ultra-Lightweight for Maximum Portability Weighs Only 11.5 lbs (5.2 kg)

The Sony/Tek 318 and 338 Logic Analyzers bring an unprecedented combination of performance, portability and low price to the field of digital test instrumentation.

Weighing only 11.5 pounds each, these instruments incorporate proprietary LSI circuitry to provide an array of features usually associated with much larger logic analyzers. Both the 318 and 338 include parallel and serial data acquisition capabilities to cover the widest possible range of applications. For software work, there is powerful multilevel triggering to capture complex real-time code execution. Each instrument can also be remotely controlled through an RS-232 interface, an extremely useful feature in first-line service applications. Also, nonvolatile memory allows both setup information and reference data to be retained and transported from site to site.

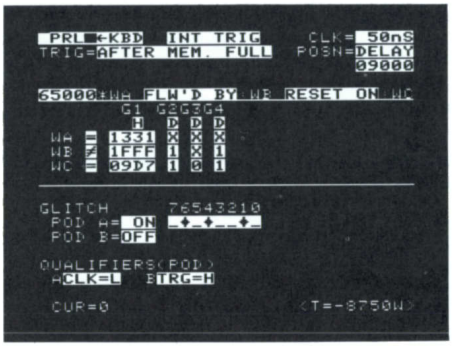
The 318 and 338 Logic Analyzers are both built around the same basic feature set. The difference between the two instruments is in maximum data width and acquisition speed. The 338, which is targeted more toward software applications, allows 32 channels of data acquisition at speeds up to 20 MHz. The 318, which is directed toward hardware applications, permits 16 channels of data acquisition at speeds up to 50 MHz.

Aside from these width/speed differences, the 318 and 338 pack the same powerful features into a highly portable instrument. The basic 318/338 includes parallel state and timing acquisition, with acquisition, reference and glitch memories.

The S1 configuration adds serial acquisition, an RS-232 interface, and nonvolatile memory.

Parallel State Acquisition

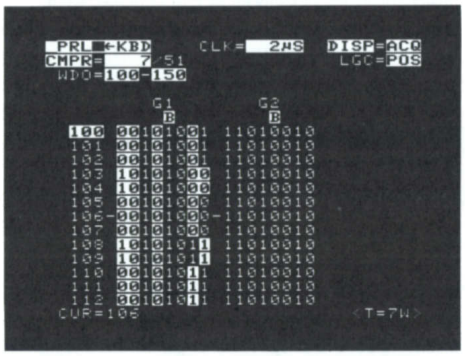
For either software or timing applications, the 318/338 contains a powerful 3-level trigger which allows the capture of complex event sequences as executed by the hardware under test.



A 3-level trigger lets you define up to three events (A,B,C) which are then combined by using various operators to form the trigger sequence.

This trigger allows three separate logic events to be defined and then combined through a series of operators to specify the actual trigger sequence. Up to 65,000 occurrences can be required for the first event to come true. The next two events can follow immediately (THEN) or later (FOLLOWED BY). Two or three events can also be ORed together. The third event can also be used to reset the trigger sequence.

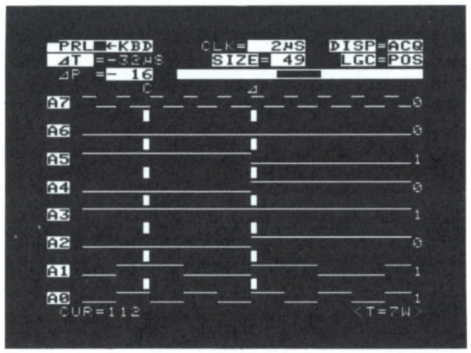
Once acquired, parallel state information can be displayed in binary, hex, octal or decimal radix. The data can be searched for each occurrence of a specified word, and can also be compared with data stored in the reference memory, with any differences highlighted on the display.



You can compare the data you have just acquired to a set of data in reference memory. All differences are displayed in reverse video.

Parallel Timing Acquisition

For timing applications data can be acquired either synchronously, using the clock of the system under test, or asynchronously, using the 318/338's own internal clock. Up to eight channels of timing data can be displayed at once, and each can be identified through a 2-character label entered by the user. For increased accuracy, there is a "delta" measurement feature which counts and displays the number of sample intervals between two movable cursors.

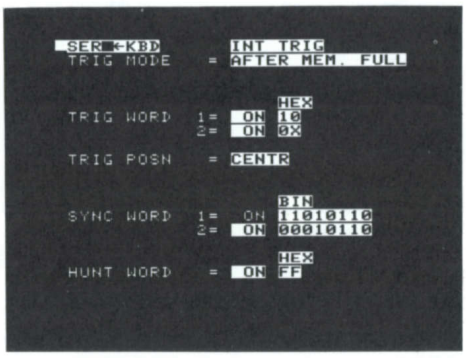


Timing displays include analysis tools such as measurements between cursors, variable grouping, memory search and glitch display.

There is also full glitch capture capability. Glitch information is automatically acquired and separately stored any time parallel data is acquired. A separate glitch trigger allows glitch occurrences to be specified on a channel-by-channel basis, with each channel of the glitch trigger ORed with its counter-part in the main trigger.

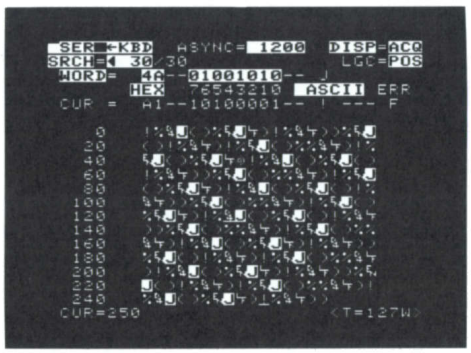
Serial Data Acquisition

A major part of the S1 configuration package is serial data acquisition, which adds considerable breadth to the instruments' application range. Serial acquisition can take place in either synchronous or asynchronous modes at up to 19200 bits/second, with either 5, 6, 7, 8 or 9 bits per character. For synchronous acquisition, the user can specify sync and hunt words as well as trigger words.



When defining a serial data acquisition trigger, you can specify sync and hunt words as well as trigger words.

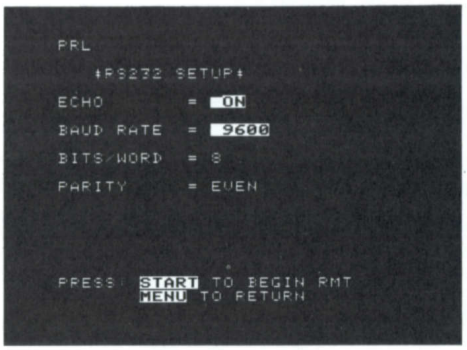
Acquired serial data can be displayed in either state table or character formats. The state table format gives a wide range of radixes, including hex, binary, ocatal, ASCII and EBCDIC. The character format provides 256-character stream displays in either ASCII or EBCDIC. In addition, acquired serial data may be searched for occurrences of a specific word and compared with data stored in reference memory.



Captured serial data can be displayed in state or character format. Data can also be searched for occurrences of a specified word.

RS-232 Interface for Remote Control

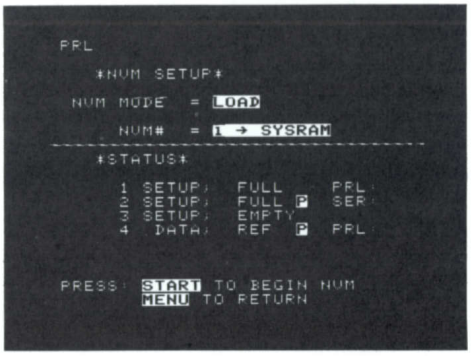
The S1 configuration package includes an RS-232 interface. This allows complete control of the instrument by a remote terminal which can be connected through either a modem or local lines. Consequently, a remote operator can define triggers, acquire data and analyze the results. In addition, the operator can input a reference pattern via a remote terminal. All aspects of the remote connection, such as baud rate, local/remote echo and bits/character, are easily set up through menu prompts supplied by the 318/338.



Setting up the RS-232 interface is simplified by easy to use menu prompts.

Nonvolatile Memory

Also included in the S1 configuration is a nonvolatile memory which allows both instrument setups and data to be preserved past power down and retained indefinitely. This memory will hold up to three setups (channel configurations, triggers and thresholds) and one set of memory data.



3 Setups and acquisition or reference memory can all be easily stored and protected in the nonvolatile memory.

NEW

LOGIC ANALYZERS

PARALLEL ANALYZER FUNCTION

DATA INPUT

Channels

318: 16 channels; glitch data is detected on all 16 channels.

338: 32 channels; glitch data is detected on 8 channels (POD A).

Minimum Logic Swing — 500 mV p-p; centered on threshold voltage.

Maximum Logic Swing — Threshold voltage plus 10 V to threshold voltage minus 15 V.

Glitch Data Width — 5 ns minimum with 350 mV overdrive from threshold.

Threshold Voltage — TTL +1.4 V; V 1 −10 V to +10 V (0.1 V step); V 2 −10 V to +10 V (0.1 V step); V 3 = (V 1 + V 2)/2.

SAMPLING

External Clock Mode	318	338
Data setup time	13 ns max	14 ns max
Data hold time	0 ns max	0 ns max
Clock period	20 ns min	50 ns min

Clock Pulse Width — High-Logic level: 15 ns min. Low-Logic Level: 15 ns.

Clock Polarity — + or −edge.

INTERNAL CLOCK MODE

Sample Interval

318: 20 ns to 500 ms/sample in 1.2.5 sequence.

338: 50 ns to 500 ms/sample in 1.2.5 sequence.

Data Memory Depth	318	338
Acquisition Memory	16 x 256 bits	32 x 256 bits
Reference Memory	16 x 256 bits	32 x 256 bits
Glitch Memory	16 x 256 bits	8 x 256 bits

TRIGGERING

Internal Trigger

Word Recognizer — Three words: A, B, and C; selected channels are AND'd together.

Input — All data input channels from P6451 data acquisition probes.

Glitch Trigger — Selected channels are OR'ed together.

Trigger Position — Begin, Center, End, Delay up to 65,000 clock cycles.

External Trigger

Input — Mini-jack connector on side panel, TTL compatible.

Threshold — 1.4 V nominal (TTL level).

Polarity — + or −edge.

Pulse Width — 20 ns minimum.

Trigger Output — Initiated high when an internal trigger sequence, glitch trigger or external trigger is detected. Reset on next acquisition start.

Output Level — TTL.

Current Max — High-Logic Level: 1 mA. Low-Logic Level: 2 mA.

DATA DISPLAY

Timing Diagram Mode — Maximum of 8 channels (one page) present on screen at one time. The 318 has two pages; the 338 has four pages.

Glitch Display: Displays glitches on timing diagram as a bit width transition edge.

Search: Searches for glitches or user defined word.

ΔT — Movable cursor for calculating the number of clocks and temporal distance between two events.

State Table Mode — Hex, decimal, octal, or binary radix format.

Search: Searches for glitches or user defined word.

Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

SERIAL STATE ANALYZER FUNCTION

DATA INPUT

Data Timing — Synchronous or asynchronous.

Bits/Character — 5, 6, 7, 8 or 9 bits (includes parity bit if parity is active).

SAMPLING

Internal Clock for Asynchronous Mode — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600, and 19,200 bits/second.

External Clock for Both Synchronous and Asynchronous Modes — Up to 19,200 bits/second.

Parity Control — Odd, even, or none.

TRIGGER SOURCE

Internal or external.

DATA DISPLAY

State Table Mode — Hex, binary, octal, ASCII, EBCDIC radix.

Search: Searches for parity errors or user defined word.

Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

Character Table Mode — All 256 bits of memory displayed in either ASCII or EBCDIC radix.

Search: Searches for parity errors or user defined word.

Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

RS-232 INTERFACE

Data Transmission Type — Asynchronous only.

Communication Mode — Full Duplex.

Bits/Character — 8 bits with parity.

Parity — Even.

Data Transfer Rate — 110, 150, 300, 600, 1200, 2400, 4800, 9600 BPS.

Signal Characteristics — Meets RS-232C standard.

I/O Connector — 25 pin standard connector.

NONVOLATILE MEMORY

Memory Size — 3 setups (serial or parallel and one memory acquisition or reference.

Nonvolatile Period — Approximately 5 years at room temperature.

POWER REQUIREMENTS

Line Voltage Range — 90 V to 132 V ac, 180 V to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

INCLUDED ACCESSORIES

Power cord (161-0104-00); accessory pouch (016-0697-00); P6107 Probe (1 additional with the S1 configuration) (010-6107-03); 2 with the 318, 4 with the 338, P6451 probe (010-6451-07); workbook, reference guide, manual.

ORDERING INFORMATION

318 Logic Analyzer **$5,300**

318S1 Logic Analyzer with Serial Analysis, RS-232 and Nonvolatile Memory **$6,500**

318F1 Field Installed Serial Analysis, RS-232 and Nonvolatile Memory **$1,500**

338 Logic Analyzer **$5,800**

338S1 Logic Analyzer with Serial Analysis, RS-232 and Nonvolatile Memory **$7,000**

338F1 Field Installed Serial Analysis, RS-232 and Nonvolatile Memory **$1,500**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

OPTIONAL ACCESSORIES

Service Manual

RS-232 Cable — Order 012-0757-00 ..... **$140**

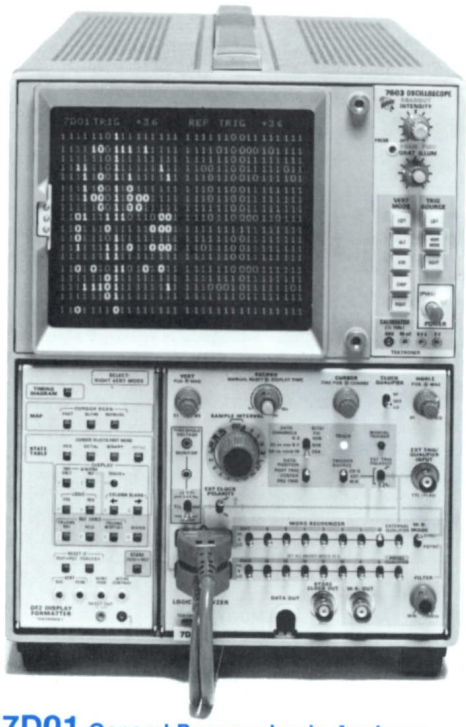
Service Maintenance Kit — Order 067-1159-01 ..... **$600**

Null Modem Cable — Order 012-0530-00 ..... **$75**

The SONY®/TEKTRONIX® 300 Series is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo Japan, Outside of Japan the 300 Series is available from Tektronix, Inc., its marketing subsidiaries and distributors.

300 SERIES COMPARISON CHART

Characteristics	308	318	318S1	338	338S1
No. Parallel Data Channels	8	16	16	32	32
Maximum Asynchronous Sample Rate	20 MHz	50 MHz	50 MHz	20 MHz	20 MHz
Maximum Synchronous Sample Rate	20 MHz	50 MHz	50 MHz	20 MHz	20 MHz
No Trigger Levels	1	3	3	3	3
Acquisition Memory Depth (Bits/Channel)	252	256	256	256	256
Reference Memory Depth (Bits/Channel)	252	256	256	256	256
Glitch Capture (Channels)	8	16	16	8	8
Signature Analysis	Yes	No	No	No	No
Serial Data Acquisition	Yes	No	Yes	No	Yes
RS-232 Interface	No	No	Yes	No	Yes
Nonvolatile Memory	No	No	Yes	No	Yes
Video Output	No	Yes	Yes	Yes	Yes
Weight	8 lb	11.5 lb	11.5 lb	11.5 lb	11.5 lb
Price	$3,950	$5,300	$6,500	$5,800	$7,000



7D01 General Purpose Logic Analyzer

- 16 Stored Channels
- Up to 1024 Words Deep
- State or Timing
- Up to 100 MHz Sample Rate
- High Impedance Probes
- 18-Bit Word Recognizer
- Clock Qualifier

The 7D01 is a dual-wide, plug-in instrument that occupies one vertical amplifier compartment and an adjacent time base compartment in 7000 Series oscilloscope mainframes. With this compatibility, you can configure a total logic analysis system. Using a four-wide mainframe oscilloscope, you can combine your logic analyzer with your analog oscilloscope and display the outputs of both at the same time.

Display Formatters

There are two display formatters available with the 7D01 Logic Analyzer—the DF1 and DF2. Both offer timing, mapping, and state table displays in binary, hexadecimal, and octal formats. The DF2 offers additional formats for IEEE Standard 488/GPIB and ASCII.

The display formatters are dedicated for use with the 7D01. They provide complete alphanumeric character generation, so that the logic analysis package can be used in mainframes without CRT readout (mainframe Option 01).

There are also two modes of automatic data acquisition in the DF1 and DF2 that compare the entire 7D01 memory to the reference memory. If a difference is detected, the difference and location will be intensified in the display readout at the top of the CRT, and the number of resets required to find the error will be displayed. This function, called RESET IF 7D01 = REF, allows full comparison of stored and newly acquired data. To compare only the tables selected by the cursor control, use RESET IF TABLES = .

Digital Latches

The DL2 and DL 502 Digital Latches extend the 7D01's measurement capabilities by detecting narrow pulses in a data stream that cannot be captured by the logic analyzer alone. Operating in an asynchronous mode, the 16-channel digital latches can detect spikes or glitches between system clock edges that are narrower than the sample clock interval or as narrow as 5 ns.

7D01 CHARACTERISTICS

The 7D01 acquires 4, 8, or 16 CH of data and stores the data in a 4 k memory. Data storage format is selectable as 4 CH X 1016 bits, 8 CH X 508 bits, or 16 CH X 254 bits.

Data sampling can be asynchronous (internal clock) or synchronous (external clock). In asynchronous modes, sampling rates can be selected up to 100 MHz in the 4 CH mode, up to 50 MHz in the 8 CH mode, or up to 20 MHz in the 16 CH mode. External sampling clocks up to 50 MHz can be used in the 4 and 8 CH modes, and up to 25 MHz in the 16 CH mode.

SIGNAL INPUTS

Clock, Qualifier, and Data Input Source — Two multilead P6451 Probes provide connections for 9 CH (9 input and ground) each. CH 0-7 and clock are through probe 1, and CH 8-15 and qualifier are through probe 2. Each probe attaches through a 25-pin connector at the 7D01 front panel.

Input Impedance — 1 MΩ paralleled by 5 pF (at probe head).

Threshold at Probe Tips — Front panel switch selects fixed TTL (+1.4 V ±0.2 V), variable (±12 V) or split (variable for top probe, TTL for bottom probe). Front panel jack monitors variable threshold only.

Minimum Logic Swing — 500 mV plus 2% of threshold voltage p-p or less, centered on the threshold voltage.

Maximum Logic Swing — −40 V or less, to at least threshold voltage plus 10 V. (Maximum nondestructive input ±40 V.)

TRIGGER

Source — Switches allow selection of pre-center, and post trigger; TTL or variable threshold levels, and use of clock qualification.

Cursor — A movable cursor provides a binary data readout of the timing diagram and the number of sample intervals from the data to the trigger position.

ENVIRONMENTAL

Temperature — Operating: 0°C to +40°C. Nonoperating: −40°C to +75°C.

Altitude — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 200 m (50,000 ft).

Vibration — With the 7D01 and DF1 or DF2 combined, frequency swept from 10 to 50 cps at one minute per sweep. Vibrate for 15 minutes along each of the 3 major axes at 0.015 inch total displacement. Hold 3 minutes at any major resonance, or if none, at 50 cps. Total time, 54 minutes.

Shock — Operating and nonoperating: 30 g's, 3½ sine 11 s duration, 2 shocks in each direction along 3 major axes, for a total of 12 shocks.

AC POWER

Line Voltage Ranges — Determined by the 7000 Series oscilloscope mainframe.

Power Consumption — 32 W at nominal line voltage.

INCLUDED ACCESSORIES

Two, P6451 Data Input Probes (010-6451-03); manual.

DF1 CHARACTERISTICS

The DF1 reformats the output of the 7D01 in a choice of five display formats including timing, mapping. and state table displays in binary, hexadecimal and octal. It imposes no significant electrical characteristics on the 7D01 which affect measurement parameters.

DF2 CHARACTERISTICS

The DF2 reformats the output of the 7D01 in a choice of seven display formats including timing, mapping, and state table displays in binary, hexadecimal, octal, ASCII and IEEE Standard 488/GPIB. It imposes no significant electrical characteristics on the 7D01 that affect measurement parameters.

INCLUDED ACCESSORIES

GPIB Probe Adaptor for the P6451 (103-0209-00). (A 24-pin IEEE Standard Connector with quick connection to the P6451 Probe Head.)

DL2 CHARACTERISTICS

The 16 channel DL2 aids the 7D01 measurement capabilities by detecting narrow asynchronous pulses of less than one sample interval or as narrow as 5 ns in a data stream. The DL2 plugs into any compartment of a 7000 Series mainframe. Two 25-pin connectors connect the DL2 with the 7D01. Data is acquired via two P6451 Probes which plug into the front panel of the DL2.

Minimum Pulse Width to Initiate Latch — 5 ns.

Minimum Amplitude to Initiate Latch — 500 mV centered at threshold.

Minimum Sample Interval Asynchronous Clock — 50 ns.

MEMORY/SAMPLING RATE

Format*1		Asynchronous*2		Synchronous*4		
Data Channels Displayed	Bits Per Channel	Maximum Sampling Rate	Minimum Data Pulse Width*3	Maximum Clock Freq	Data Set-up Time Required	Data Hold Time Required
0-3	1016	100 MHz	15 ns	50 MHz	20 ns	0
0-7	508	50 MHz	25 ns	50 MHz	20 ns	0
0-15	254	20 MHz	55 ns	25 MHz	23 ns	0

*1 *Front panel selectable.*

*2 *Sampling Intervals are selectable from 10 ns to 5 ms in 18 steps using a 1-2-5 sequence.*

*3 *Minimum data pulse width to insure recording is one sample interval +5 ns.*

*4 *+ or − edge of clock pulse can be selected to initiate sample.*

ORDERING INFORMATION

7D01F Logic Analyzer (7D01 and DF1 Display Formatter)	**$6,950**
7D01F2 Logic Analyzer (7D01 and DF2 Display Formatter)	**$7,500**
7D01 Logic Analyzer	**$4,800**
DF1 Display Formatter	**$2,150**
DF2 Display Formatter	**$2,700**
DL2 Digital Latch	**$2,100**
DL 502 Digital Latch	**$1,900**
7603 Oscilloscope	**$2,865**
Option 01 — (Deletes one readout board)	**−$300**
7704A Oscilloscope	**$4,520**
Option 01 — (Deletes one readout board)	**−$300**

7D02 Microprocessor Analyzer

3-Wide 7000 Series Plug-in Module

Traces Complex State Flow Quickly and Easily

Disassembles State Tables into Mnemonics for Fast, Accurate Interpretation

Supports 8- and 16-bit Microprocessors

The 7D02 Logic Analyzer acquires up to 52 channels of state information synchronously. The basic instrument has 28 channels, enough for 8-bit microprocessors. Option 03 increases the number of channels to 44, for support of 16-bit microprocessors. Option 01 provides an additional group of 8 channels which can be used to acquire timing information asynchronously or to acquire state data synchronously.

Synchronous resources include four independent word recognizers, two universal time/event counters which can be interactive and can be reset on the fly, and several modes of data qualification. Asynchronous resources include a word recognizer and an 8-channel glitch recognizer with an independent memory. These resources can be programmed to construct trigger or data qualification conditions.

The 7D02 interfaces to microprocessors via the PM 100 Series of personality modules, most of which provide a specific single-connection interface to the microprocessor and appropriate processor mnemonics. The only exception is the PM 101, a general-purpose module for non-microprocessor logic analysis or for processors not supported by the other PM 100 modules.

CHARACTERISTICS

DISPLAY

Type — State Table, raster scan.

Format — 32 characters/line, 24 lines.

Channels Displayed

Basic 7D02: 28; (8 Data, 16 Address, 4 Control).

Acquisition Memory Locations Displayed — 19 maximum.

Radices Available — Data: ASCII, Hex, Binary, Octal. (Mnemonic disassembly for each supported microprocessor). Address: ASCII, Hex, Binary, Octal. Control: Binary, Mnemonic Disassembly.

SIGNAL INPUTS

Signal inputs for the 7D02 are obtained through optional Personality Modules which (along with Option 03) determine the number of input channels available.

Input Channels, Basic 7D02 — 35; (8 Data, 16 Address, 10 Control, 1 External Trigger).

Input Impedance — Determined by Personality Module used.

External Trigger — Input Impedance: 1 MΩ ±2% (compatible with 10X Coded Probe). Threshold: 1.4 V. Setup Time: 10 ns (at BNC). Hold Time: 18 ns (at BNC).

CLOCK SYNCHRONOUS ONLY

Raw Clock Input — 20 MHz maximum.

Time Between Qualified Clocks — ⩾100 ns.

Setup/Hold Time — Determined by Personality Module used.

Number of Qualifiers — Six maximum (can shift or divide qualified clocks by up to four positions or times).

DATA QUALIFICATION

Complex Data Qualification allows the acquisition memory to be turned on and off at any time using Word Recognizers and Counters. This process simulates a large acquisition memory and pattern search capability.

MEMORY SIZE (BASIC 7D02)

Acquisition Memory — 28 x 256 bytes.

Storage Memory — 28 x 256 bytes.

COUNTERS

Universal Counters — Two.

Counting Mode — Resolution, Time Mode: 1 ms or 1 μs. Accuracy: (±1 count) x (number of start/stop cycles) ±0.01% of value. Maximum Count: 65,534. Event Mode Maximum Count: 65,534.

Control Mode — Resolution, Time Mode: 1 ms or 1 μs. Minimum Interval Generated: 2.0. Maximum Interval Generated: 65,534. Generating Interval Accuracy: (−0, +1 count) x (number of start/stop cycles) ±(0.01% of value) + (0 to 0.2 μs). Events Mode Minimum Count: 2.0. Maximum Count: 65,534.

WORD RECOGNIZERS

Word Recognizers — Four.

Channels (Basic 7D02) — 31 (32 if timing option (01) is installed).

TRIGGERING

Can be triggered from any of the word recognizers or from either of the counters, in the control mode. (Has ability to track and trigger on very complex program flows).

Trigger Position (Number of qualified clocks displayed after the trigger point) — Trigger Before Data: 240. Trigger Centered: 128. Trigger After Data: 16. Zero Delay: Zero.

Trigger Output — TTL compatible (capable of driving a 50 Ω unterminated transmission line).

Accuracy — One qualified clock +86 ns ±35 ns after event at probe tip.

PROCESSOR HALT

The Processor can be halted when the 7D02 stops acquisition.

Processor Halt Delay — Two qualified state clocks after the 7D02 stops acquisition plus Personality Module delay time.

OTHER CHARACTERISTICS

Ac Power — Line Voltage Ranges: Determined by 7000 Series mainframe. Power Consumption: 49 W maximum at nominal line voltage (all options).

Size — Three wide 7000 Series plug-in.

Weight — 3.6 kg (8 lb).

Temperature Range — Operating: 0°C to 50°C. Nonoperating: −55°C to +75°C.

Altitude Ranges — Operating: Sea level to 4500 m (15,200 ft). Nonoperating: 15 000 m (50,000 ft).

OPTION 01 — TIMING OPTION

SIGNAL INPUTS

Number of Channels — Eight (using a P6451 Data Probe). Input Impedance: 1 MΩ shunted by ≈5 pF.

Logic Swing — Minimum: 500 mV +2% of threshold voltage centered on threshold voltage. Maximum: −15 V to at least threshold voltage +10 V. Maximum Nondestruct Input Voltage: −40 V to at least +40 V.

Threshold Voltage — Programmable from −6.35 to +6.35 in 50 mV increments.

Data Setup/Hold Time — Data Setup: 20 ns. Data Hold: 2 ns.

CLOCK

Asynchronous — Sample Rates: 20 ns to 5 ms in a 1-2-5 sequence. Accuracy: ±0.01%.

Synchronous — Maximum raw input clock frequency: 20 MHz. (Obtained from system under test via the Personality Module). Minimum Time Between Qualified Clocks: 100 ns.

MEMORY SIZE

Acquisition Memory — 8 x 255 bytes.

Glitch Memory — 8 x 255 bytes.

WORD RECOGNIZERS

One Data Word Recognizer — Eight channels (ANDed together).

One Glitch Word Recognizer — Eight channels (ORed together but ANDed with the Data Word Recognizer).

External Trigger In — Can function as a word recognizer.

TRIGGERING

Sources — Timing Option Data Word Recognizer; Timing Option Glitch Word Recognizer; Main Section (7D02) Word Recognizers; External Trigger In.

DIGITAL DELAY

Maximum Delay — 65,534 sample clocks.

GLITCH LATCH

Pulse Width — >5 ns. Asynchronous Mode only.

DISPLAY

Timing Diagram Mode — Number of Channels: Eight. Window Size: 124 words in X1 mode or 31 words in X4 mode. (Data channels can be relocated by the user). Numeric Formats: Hex, Octal, Binary, ASCII. Glitch displayed as an * in the table beside DATA. Timing Display: Glitches are displayed by an ↓ above the line where the glitch occurred. Maximum Number of Words Displayed: 19. Numeric Formats: Hex, Binary, Octal, ASCII. Number of Words Scrolled: 255. Trigger Position Accuracy: ±1-bit (Asynchronous Mode).

MISCELLANEOUS

The P6451 Data Acquisition Probe comes standard with an Option 01.

OPTION 03 — EXPANSION OPTION

The Expansion Option provides the 7D02 with the ability to support most 16-bit microprocessors.

SIGNAL INPUTS

Adds an additional 16 bits to the 7D02. 8 Data, 8 Address.

WORD RECOGNITION

Maximum Number of Channels — 48; (16 Data, 24 Address, 6 Control, 1 External Trigger, 1 Timing Option (if timing option installed).

DISPLAY

Maximum Number of Channels — 44; (16 Data, 24 Address, 4 Control).

MEMORY SIZE

Acquisition Memory — 44 x 256 bytes.

Storage Memory — 44 x 256 bytes.

ORDERING INFORMATION

7D02 Logic Analyzer **$4,950**

Option 01 — Timing ..... **+$2,150**

Option 03 — Expansion ..... **+$1,350**

Option 7D02F01 — Timing, Field-Installed **$2,500**

Option 7D02F03 — Expansion, Field-Installed **$1,550**

OPTIONAL ACCESSORIES

Hardware Kit — electrical equipment (fits any 7600 or 7400 mainframe). Order 016-0669-00 ..... **$10**

Service Maintenance Kit — Order 067-0939-00 ..... **$750**

PM 100 Microprocessor Personality Modules

Single-Plug Connection to Microprocessors

Support Mnemonic Disassembly

Interface with 7D02 and DAS 9100/PMA 100

The PM 100 Personality Modules are high performance, single-plug interconnection modules which interface microprocessors to the 7D02 and the DAS 9100/PMA 100 logic analyzers. The PM 102 through PM 111 are dedicated to specific microprocessors. The PM 112 supports the MULTIBUS. The PM 101 is a general-purpose module which the user configures to support his particular circuit—typically a processor not supported by the rest of the PM 100 series.

The modules operate synchronously with the processor under test to demultiplex buses, synthesize signals for tracking processor status, and transfer data to acquisition memory. A synthesized control function allows triggering or data qualification on instruction fetches.

When used with the 7D02, the personality modules allow the word recognizer displays to be formatted in the mnemonics of the processor control signals. The processor may be halted by the personality module when the 7D02 triggers.

When used with the DAS 9100 and PMA 100, the personality modules provide a quick, reliable hardware interface that complements the performance of DAS 91A32 modules (see DAS 9100). The PMA 100 also interfaces to the DAS 91A21 modules, but for the 91A24 modules, we recommend you consider the alternative of using 91TM support (see page 83).

PM 100 Series Microprocessor Modules with DAS 9100 and PMA 100

COMMON CHARACTERISTICS

Temperature — Operating: −15°C to +55°C except for PM 109 which is 0°C to +50°C. Nonoperating: −62°C to +85°C except for PM 109 which is −55°C to +75°C.

Altitude — Operating: 4.5 km (15,000 ft). Nonoperating: 15 km (50,000 ft).

PHYSICAL CHARACTERISTICS

	PM 101,102,103 104,105,108		PM 106,107 109,111		PM 112	
Dimensions	**mm**	**in**	**mm**	**in**	**mm**	**in**
Width	120	4.7	120	4.7	170	6.7
Height	170	6.7	48	1.9	157	6.2
Depth	203	8.0	203	8.0	305	12.0
Weights	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net	1.2	2.6	1.2	2.6	1.2	2.6

Cable Lengths from Module to 7D02 — 1.22 m ±25 mm.

Module to μp — 330 mm ±12 mm. (Except for PM 101 which is 350 mm ±13 mm and PM 111 which is 470 mm ±1.3 mm.)

PM 100 SERIES MICROPROCESSOR SUPPORT CHART

For the DAS 9100 (using the PMA 100) and the 7D02

Microprocessor Type	Support Features*1	Personality Module Available
8-BIT		
8080	FM, DM	PM 101 OPT 01
8085	FM, P-C, DM	PM 104
Z80	FM, P-C, DM	PM 105
6800	FM, P-C, DM	PM 102
6802/6808	FM, P-C, DM	PM 103
6809/6809E	FM, P-C, DM	PM 111
6502	FM, DM	PM 101 OPT 02
1802	STD, DM	PM 101 and 062-6001-00 (Application Manual)
8031	STD, DM	PM 101 and 062-6003-00 (Application Manual)
8039/8035	STD, DM	PM 101 and 062-5999-00 (Application Manual)
8048/8049	STD, DM	PM 101 and 062-5999-00 (Application Manual)
8051	STD, DM	PM 101 and 062-6003-00 (Application Manual)
8748	STD, DM	PM 101 and 062-5999-00 (Application Manual)
8751	STD, DM	PM 101 and 062-6003-00 (Application Manual)
6801/6803	STD, DM	PM 101 and 062-6000-00 (Application Manual)
16 BIT		
8086	FM, P-C, DM	PM 106
8088	FM, P-C, DM	PM 107
Z8001	FM, P-C, DM	PM 110
Z8002	FM, P-C, DM	PM 108
68000	FM, P-C, DM	PM 109
9900 TMS/SBP	STD, DM	PM 101 and 062-6002-00 (Application Manual)
MULTIBUS*2	CM, STD, P-C, DM	PM 112

*1 *FM — Full Mnemonic Disassembly*
CM — Control Mnemonics
DM — Mnemonics may be developed using DAS Define Mnemonics
P-C — Pre-Configured, Single Plug, Interconnection
STD — Standard Radices (Hex, Binary, Octal)

For those 8-bit and 16-bit microprocessors not currently supported by specific personality modules, and for general purpose applications, the PM 101 General Purpose Personality Module or DAS Define Mnemonics capabilities are available. See Data Sheet AX-4489 for details on PM 101.

*2 *MULTIBUS is a registered trademark of Intel Corp.*

ORDERING INFORMATION

PMA 100 Personality Module Adaptor (Includes Motorola Tape) **$2,500**

Option 01 — Delete Motorola Disassembly Tape ..... **−$175**

Option 02 — Delete Motorola Disassembly Tape, Add Intel Tape (062-8589-00) ..... **NC**
Additional Intel Tape Order 062-8589-00 ..... **$225**

Option 03 — Delete Motorola Disassembly Tape, add Zilog Tape (062-8591-00) ..... **NC**
Additional Zilog Tape Order 062-8591-00 ..... **$225**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro, 220 V/16 A, 50 Hz

Option A2 — UK, 240 V/13 A, 50 Hz

Option A3 — Australian, 240 V/10 A, 50 Hz

Option A4 — North American, 240 V/15 A, 60 Hz

Option A5 — Switzerland, 220 V/10 A, 50 Hz

PM 101 General Purpose **$1,400**

Option 01 — 8080 Mnemonics ..... **+$300**

Option 02 — 6502 Mnemonics ..... **+$300**

PM 102 6800 ..... **$1,400**

PM 103 6802/6808 ..... **$1,400**

PM 104 8085 ..... **$1,400**

PM 105 Z80 ..... **$1,400**

PM 106 8086 ..... **$1,800**

Option 01 — With Service Test Unit ..... **+$500**

PM 107 8085 ..... **$1,800**

Option 01 — With Service Test Unit ..... **+$500**
Or Service Test unit may be ordered separately:
without power supply Order 067-1024-00 ..... **$500**

PM 108 Z8002 ..... **$2,000**

PM 109 68000 ..... **$2,000**

Option 01 — With Service Test Unit ..... **+$1,200**
Or the Service Test Unit can be ordered separately:
Order 067-1025-00 ..... **$1,200**

PM 110 Z8001 ..... **$2,000**

PM 111 6809/6809E **$1,600**

40 Pin Low Profile Dip Clip Adaptor — 100 mm Version
Order 015-0339-00 (Recommended) **$44**
Female Adaptor — Order 380-0647-01 ..... **$30**
40 Pin Dip Socket — Order 136-0623-00 ..... **$2.40**

PM 112 Multibus **$1,400**

Set of 10 Leads — with E-Z Micro Hook Tips.
Order 012-0670-00 ..... **$65**

Microprocessor and Bus Support

Standard Modules for Many Microprocessors

Single-Plug Connection for Ease of Use and Reliability

Ready-to-Use Mnemonics on Tape or ROM Pack

PM 200 Personality Modules for Advanced Microprocessors

Tektronix logic analyzers offer wide-ranging microprocessor support with a selection of single-plug connectors and mnemonic disassembly packages.

For custom microprocessors, or microprocessors not listed below, Tektronix offers support through EDM (Extended Define Mnemonics) on the DAS 9100, which is described on page 64. Also, the Universal Probe Interface Kit (UPIK40) on page 87 is a general-purpose, single-plug connection.

In addition to microprocessors, Tektronix offers support for several popular bus implementations, including the UNIBUS, the Q-BUS, and the GPIB (IEEE-488), and the ASCII and EBCDIC character codes.

The Option 01 probe interface works with the mnemonics files on tape or ROM pack to support disassembly on the DAS 9100 and the 1240.

Table A contains information about the microprocessor support available for the 1240. Table B describes the microprocessor support on the DAS 9100, using 91A24 Data Acquisition Modules. Table C covers bus support on the DAS 9100, again using 91A24 modules. If you wish to use 91A32 Data Acquisition Modules, please refer to page 81 for information about the PMA 100 Personality Module Adaptor and the PM 100 Personality Modules.

For microprocessor support on the 7D02 Logic Analyzer, please refer to pages 80 and 81.

TABLE A
ORDERING AND CONFIGURATION GUIDE FOR 1200 SERIES MICROPROCESSOR SUPPORT

Microprocessor	For Mnemonics ROM Pack Order	For Probe Interface Order	For PM 200 Support Order	Total No. 1240D2's Required	Total No. Probes[1] Required	Processor Clock Rate Supported
8080	12RM01	Opt 01		2	4	Max
8085	12RM02	Opt 01		2	4	Max
8086 (DIP)	12RM03		Opt 02	3	None	10 MHz
8088 (DIP)	12RM04		Opt 02	3	None	10 MHz
80186 (LCC)	12RM05		Opt 02	3	None	10 MHz
80188 (LCC)	12RM06		Opt 02	3	None	10 MHz
6800	12RM21	Opt 01		2	4	Max
6802	12RM22	Opt 01		2	4	Max
6808	12RM23	Opt 01		2	4	Max
6809	12RM24	Opt 01		2	4	Max
68000 (DIP)	12RM25		Opt 02	3	None	12.5 MHz
68008 (DIP)	12RM26		Opt 02	3	None	8 MHz
Z80	12RM41	Opt 01		2	4 †	Max
Z8001	12RM42			3	4	Max
Z8002	12RM43	Opt 01		3	3	Max
6502/65C02	12RM63	Opt 01		2	4 *	Max
F9450	12RM62			3	3	Max
NSC 800	12RM71	Opt 01		2	4 †	Max

*[1] For most of the above processors, either P6460 or P6462 data acquisition probes can be used. *For those marked with a "*", P6460's are required if you're using a CMOS version of the processor. †For those marked with a "†", P6460's are always required.*

ORDERING INFORMATION

For all items in Table A, prices are as follows:

12RMXX Mnemonics ROM Pack **$400**
Option 01 Probe Interface ..... **+$200**
Option 02 PM 200 Support ..... **+$2,100**

TABLE B
ORDERING AND CONFIGURATION GUIDE FOR DAS 9100 SERIES MICROPROCESSOR SUPPORT

Microprocessor	For Mnemonics Tape Order	For Probe Interface Order	For PM 200 Support Order	Total No. 91A24 & 91AE24's Required	Total No. Probes[1] Required	Processor Clock Rate Supported
8080	91TM01	Opt 01		2	4	Max
8031	91TM07	Opt 01		2	4 †	Max
8039	91TM10	Opt 01		1	3 †	Max
8085	91TM02	Opt 01		2	4	Max
8086 (DIP)	91TM03		Opt 02	2	None	10 MHz
8088 (DIP)	91TM04		Opt 02	2	None	10 MHz
80186 (LCC)	91TM05		Opt 02	2	None	10 MHz
80188 (LCC)	91TM06		Opt 02	2	None	10 MHz
6800	91TM21	Opt 01		2	4	Max
6801	91TM28	Opt 01		2	4	Max
6802	91TM22	Opt 01		2	4	Max
6803	91TM29	Opt 01		2	4	Max
6805[2]	91TM30	UPIK40		2	4 *	Max
6808	91TM23	Opt 01		2	4	Max
6809	91TM24	Opt 01		2	4	Max
68121	91TM32			2	4	Max
68000 (DIP)	91TM25		Opt 02	2	None	12.5 MHz
68008 (DIP)	91TM26		Opt 02	2	None	8 MHz
Z80	91TM41	Opt 01		2	4 †	Max
Z8001/03	91TM42			2	4	Max
Z8002/04	91TM43	Opt 01		2	3	Max
6502/65C02	91TM63	Opt 01		2	4 *	Max
1802	91TM61	Opt 01		2	4 *	Max
1805	91TM65	Opt 01		2	4 *	Max
F9450	91TM62			2	3	Max
1750A	91TM64			2	N/A	N/A
NSC 800	91TM71	Opt 01		2	4 †	Max

*[1] For most of the above processors, either P6460 or P6462 data acquisition probes can be used. *For those marked with a "*", P6460's are required if you're using a CMOS version of the processor. †For those marked with a "†", P6460's are always required.*
[2] supports the 146805E2.

ORDERING INFORMATION

For all items in Table B, prices are as follows:

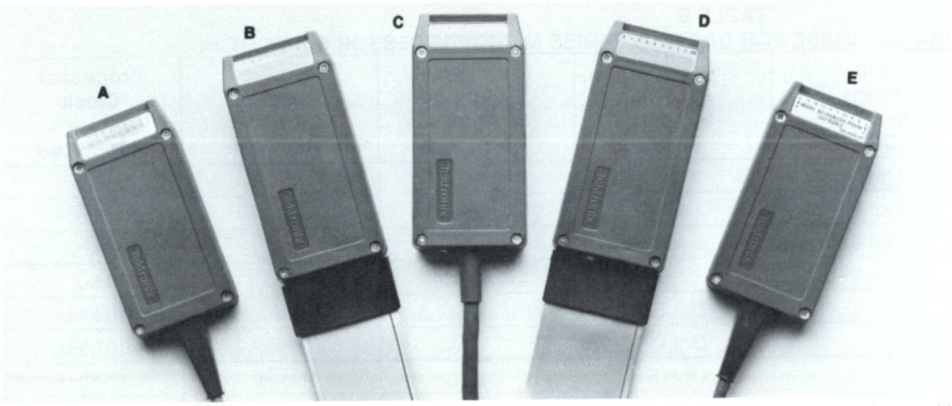
91TMXX Mnemonics Tape **$350**
Option 01 Probe Interface ..... **+$200**
Option 02 PM 200 Support ..... **+$2100**
UPIK40 ..... **+$175**

TABLE C
ORDERING AND CONFIGURATION GUIDE FOR DAS 9100 SERIES BUS SUPPORT

Bus/Code	For Mnemonics Tape Order	For Probe Interface Order	Total No. 91A24 & 91AE24's Required	Total No. Probes Required	Bus Clock Rate Supported
UNIBUS	91TM51		2	4	Max
Q-BUS	91TM52		2	4	Max
GPIB/ASCII/EBCDIC	91TM53	Opt 01	1	3	Max

ORDERING INFORMATION

91TM51 or 91TM52 Mnemonics Tape ... **$350**
91TM53 Mnemonics Tape **$200**
91TM53 Option 01 Probe Adaptor ..... **+$200**



ACQUISITION PROBES

A. P6451 8-Channel Data Acquisition Probe — for use with 7D01, 7D01F, 7D01F2 and 7D02 Opt 1.
Order P6451 010-6451-03 ..... **$545**

P6451 — for use with 300 Series Instruments (right-angle connector to analyzer)
Order P6451 010-6451-05 ..... **$545**

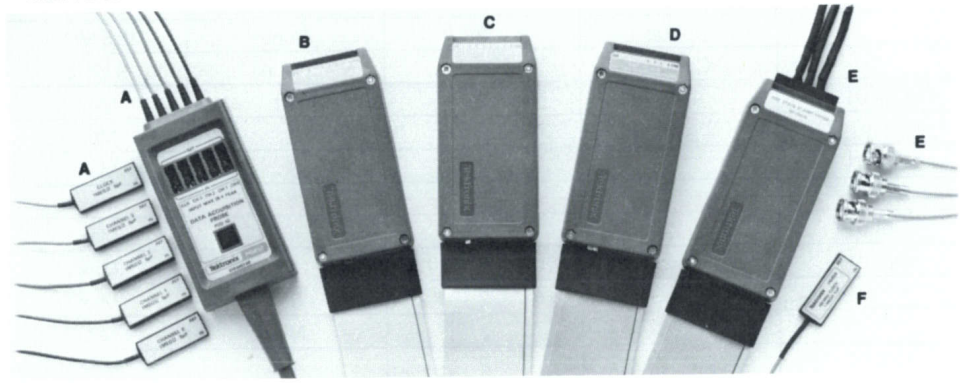
B. P6452 8-Channel Data Acquisition Probe — for use with DAS 9100 mainframes, DAS 91A32 modules, and DAS 91A08 modules.
Order P6452 ..... **$730**

C. P6460 8/9-Channel Data Acquisition Probe — for use with 1240D1, 1240D2, DAS 91A24 and 91AE24 modules. Order P6460 ..... **$700**

D. P6462 8/9-Channel TTL Only Data Acquisition Probe — for use with 1240D2, DAS 91A24 DAS 91AE24 and DAS 91A32 modules. Order P6462 ..... **$340**

E. P6406 16-Channel Word Recognizer Probe — Replacement for Sony/Tektronix 308 Opt 01 only.
Order P6406 ..... **$570**

All Probes include lead sets.



A. P6453 4-Channel Data Acquisition Probe — High speed probe for DAS 91A04, DAS 91AE04, DAS 91A04A and DAS 91AE04A. Order P6453 ..... **$1,560**

B. P6455 TTL/MOS Pattern Generator Probe 8-Channels — for use with DAS 91P16 and DAS 91P32 modules.
Order P6455 ..... **$575**

C. P6456 ECL Pattern Generator Probe 8-Channels — for use with DAS 91P16 and DAS 91P32 modules.
Order P6456 ..... **$575**

D. P6457 TTL/MOS Pattern Generator Probe 4-Channels, Individually Tri-Stateable — for use with DAS 91P16 and DAS 91P32 modules. Order P6457 ..... **$575**

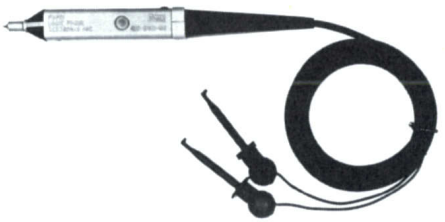
E. State Stamp Probe — for use with DAS 9100 system in Digital Design Lab (DDL) Configuration.
Order 021-0366-01 ..... **$1,200**

F. P6454 100 MHz Clock Probe — for use with DAS 91A08 module (max. of 1 P6454 per DAS system).
Order P6454 ..... **$265**

All probes include lead sets.

PROBE APPLICATION MATRIX

PRODUCT	P6451	P6452	P6453	P6454	P6455	P6456	P6457	P6460	P6462
91A24, 91AE24								●	●
91A32		●							●
91A08		●		●					
91A04A, 91AE04A			●						
91P16, 91P32					●	●	●		
1240D1								●	
1240D2								●	●
338, 318, 308	●								
7D01, 7D02 w/Opt 01	●								



P6401 Logic Probe

The small, lightweight, hand-held P6401 indicates the state of logic levels in TTL, DTL, or any other system with threshold between 0.7 and 2.15 volts. A strobe input can be used to detect the coincidence of logic signals at two points. An indication of whether a logic pulse has or has not occurred can be obtained in a "store" mode.

Power may be obtained from the unit under test or any 5 V supply.

Two bright lights in the probe tip indicate condition of the logic signal.

CHARACTERISTICS

Logic Level Thresholds
0 or Low (Lamp Extinguishes): +0.7 ± 0.1 V dc.
1 or High (Lamp Illuminates): +2.15 ± 0.15 V dc.

Minimum Recognizable Pulse Width — 10 ns.

Impedance — ≈7.5 kΩ paralleled by ≈6 pF.

Minimum Circuit Resistance for Open Circuit Indication — 10 kΩ.

Maximum Safe Input — ±150 V (dc or RMS).

Minimum Recognizable Strobe Pulse Width — 20 ns.

Maximum Safe Strobe Input — ±30 V (dc or RMS).

Strobe Input Impedance — 5.6 kΩ within 20%.

INCLUDED ACCESSORIES

Hook tip (206-0114-00); probe tip to 0.025 in square pin adaptor (206-0137-01); two alligator clips (344-0046-00); strobe lead (175-0958-01); strobe lead (175-0958-00); white plug (348-0023-00); accessory pouch (016-0537-00).

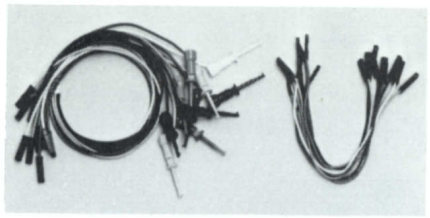
P6401 Logic Probe Order 010-6401-01 ..... **$160**

Accessory Pouch — Convenient for carrying manuals, probes and other accessories for 1240 and DAS 9100 logic analyzers
Order 016-0707-00 ..... **$60**

OPTIONAL ACCESSORIES

A. Individual Hook Tip Lead Set — 10 Leads, 16 inch, color coded with E-Z Micro Hook Tips. Order 012-0670-00 **$65**

A



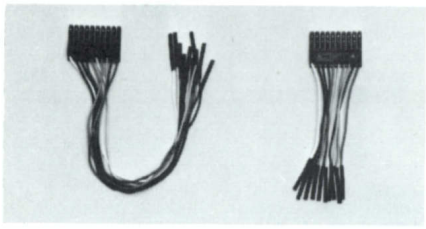
G

G. Individual Lead Set —10 leads, 16 inch, color coded, connects to .025 inch square pins, grabber tips not included. Order 012-0655-01 ..... **$40**

***Individual Lead Set** — 10 leads, 8 inch, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-0655-02 ..... **$80**

B. Flying Lead Set — 10 wide comb, 10 inch, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-0747-00 ..... **$50**

B

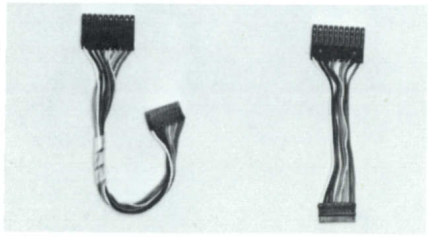


H

H. Flying Lead Set — 10 wide comb, 5 inch, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-0987-00 ..... **$40**

C. Harmonica Lead Set — 10 wide comb to 10 position single row connector, for 0.025 inch square pins on 0.1 centers, 10 inch, color coded. Order 012-0800-00 ..... **$30**

C

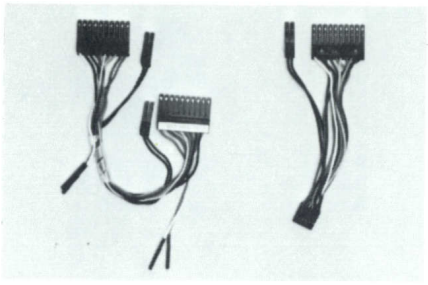


I

I. Harmonica Lead Set — 10 wide comb to 10 position single row connector, for 0.025 inch square pins on 0.1 inch centers, 5 inch, color coded. Order 012-0968-00 ..... **$21**

D. Diagnostic Lead Set, DAS 9100 — 10 wide comb to 10 wide comb with 2 wide ground jumper, 10 inch, for connecting pattern generator probes to data acquisition probes. Order 012-1000-00 ..... **$75**

D

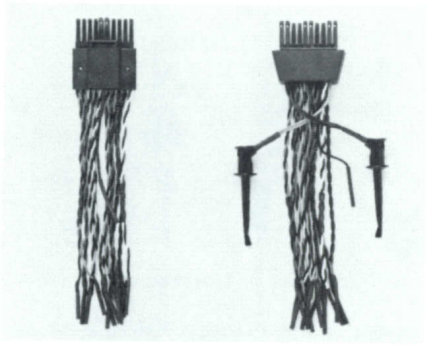


J

J. Diagnostic Lead Set, 1240 — 10 wide comb with 2 wide ground to 12 position double row connector, for 0.025 inch square pins on 0.1 inch centers, 10 inch, color coded. Order 012-0556-00 ..... **$50**

E. Pattern Generator Lead Set — 10 + 2 wide comb, 9 inch, twisted pairs, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-0926-00 .. **$100**

E

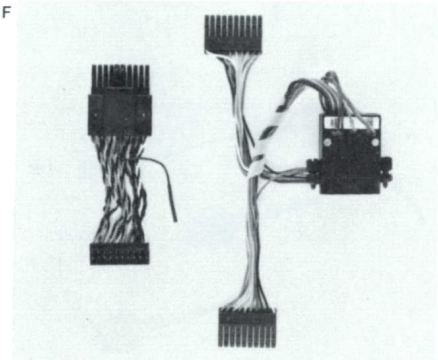


K

K. Pattern Generator Lead Set — 10 + 6 wide comb with VH and VL Pomona Hook Tips, 9 inch, twisted pairs, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-1053-00 ..... **$110**

F. High Speed Pattern Generator Lead Set — 10 + 2 wide comb to 20 position double row connector, for 0.025 inch square pins on 0.15 inch centers, 5 inch, color coded. Order 012-1001-00 ..... **$75**

F



L

L. GPIB Adaptor — Two 10 wide combs to IEEE-488 Bus Connector, 10 inch. Order 103-0209-01 ..... **$180**

*Not Shown

A. Low Profile Dip Clip — 40 pin dip to 40 position double row connector, for 0.025 inch square pins on 0.1 inch centers, 4 inch (requires male adaptor below). Order 015-0339-00 ..... **$44**

***Low Profile Dip Clip** — 40 pin, same as above except 12 inch. Order 015-0339-02 ..... **$44**

B. 40 Pin Male Adaptor — 40 position double row header with 0.025 inch square pins on 0.1 inch centers, interfaces the PM 101 or flying lead sets to low profile dip clip above. Order 380-0560-05 ..... **$15**

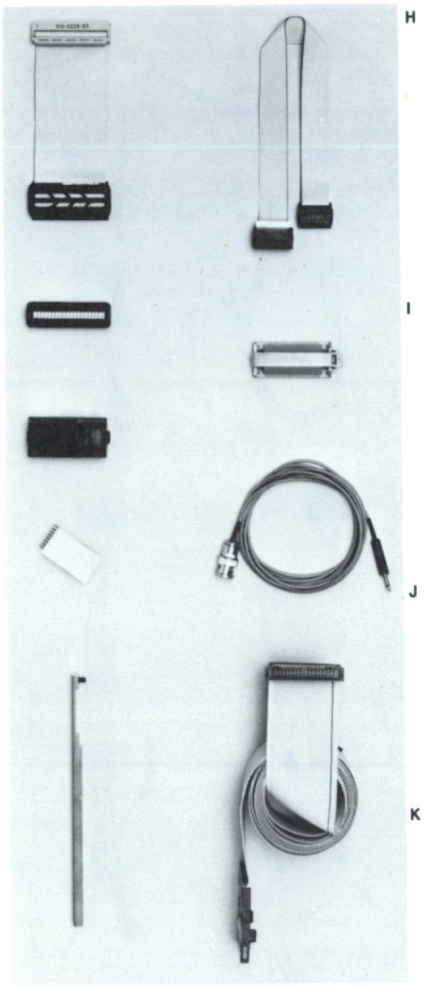
C. 40 Pin Dip Socket Female Adaptor — 40 position double row head with 0.025 inch square pins on 0.1 inch centers to 40 pin dip socket, for interfacing 40 pin low profile dip clips to PM 100 series probes. Order 380-0647-01 ..... **$30**

D. IC Clip — 16 pin dip, clothes pin style. Order 003-0709-00 ..... **$31**

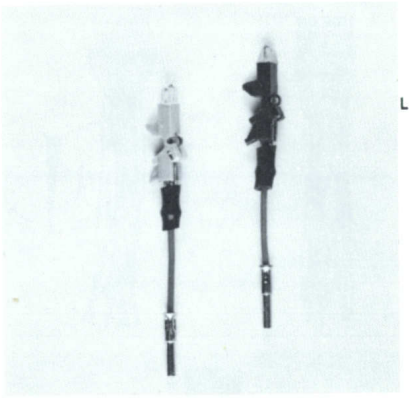
***IC Clip** — 24 pin dip, clothes pin style. Order 003-0823-00 ..... **$30**

***IC Clip** — 40 pin dip, clothes pin style. Order 003-0801-00 ..... **$43**

E. Circuit Board Ejector Tool — for removing DAS 9100 module cards. Order 214-3154-00 ..... **$4.50**



F. High Speed Grippers — Package of 10, 1.75 inch, for Dip packages with 0.1 inch lead spacing, use with P6453 or P6454. Order 195-2234-06 ..... **$75**



G. Sense Leads — Package of 10, 2 wide comb to Pomona Hook Tip, 5 inch, black for ground or VL. Order 012-0989-01 ..... **$110**

***Sense Leads** — Package of 10, 2 wide comb to Pomona Hook Tip, 5 inch, green for ground or VH. Order 012-0990-01 ..... **$75**

H. Low Profile Dip Clip — 16 pin dip to 16 position double row header with 0.025 inch square pins on 0.1 inch centers, 12 inch. Order 015-0330-00 ..... **$35**

I. Flat Cable Mounts — Adhesive Back for securing and organizing probes with flat ribbon cables. Order 343-1048-00 ..... **$0.95**

J. Sync Out Cable — Minature Phone Plug to BNC, 79 inch, for 91A24 sync output. Order 175-8165-00 ..... **$29**

K. Probe Extender Cable — Male to Female 34 position double row connectors compatible with P6452, P6462, 6 feet. Order 012-1012-00 ..... **$110**

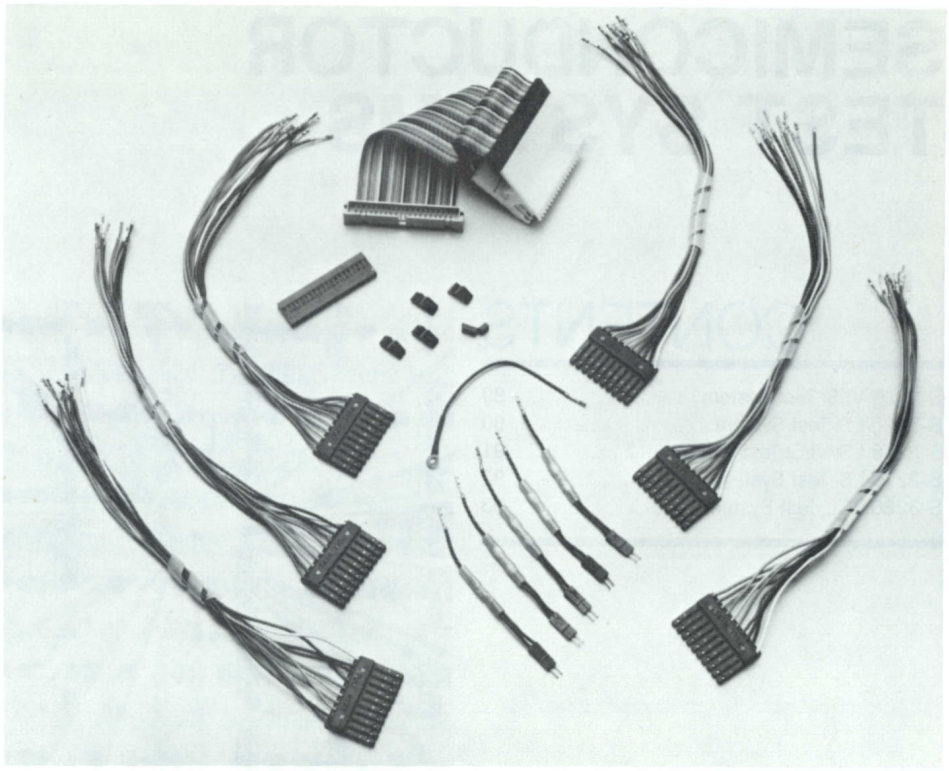
L. High Speed Grippers — Package of 10, 1.75 inch, for flat packages with 0.05 inch lead spacing, use with P6453 or P6454. Order 195-1943-06 ..... **$75**

M. Grabber Tip — Package of 12 for general purpose probing with various lead sets or PM 101. Order 020-0720-00 **$33**

N. High Speed Clock Lead — with grabber tip, package of 2, for use with P6454 100 MHz clock probe. Order 195-3659-00 ..... **$15**

** Not Shown*

UPIK 40, Universal Probe Interface Kit — For 40 pin dip packages. Allows user to configure interconnect from 6 probes or less to a clothes pin style 40 pin IC clip. Order UPIK 40 .... **$175**



***Null Modem Cable** — Female to female, 60 inch.
Order 012-0820-00 ..... **$80**

***Null Modem Cable** — Female to female, 60 inch.
Order 012-0530-00 ..... **$75**

***RS-232 Cable** — Male to female, 2 meter.
Order 012-0815-00 ..... **$55**

***Parallel Interface Cable** — 2 meter, for connecting 1200C11 Parallel Printer Comm Pack to Centronix type printer interface.
Order 012-0997-00 ..... **$55**

***Tilt Bail** — for DAS 9100. Order 348-0727-01 ..... **$9.50**

***Rackmount Kit** — for DAS 9100.
Order 016-0463-00 ..... **$200**

***Scope Mobile Cart** — fits DAS 9100, color compatible. Order 205D **$475**

***GPIB Cable** — 2 meter. Order 012-0630-01 ..... **$75**

***GPIB Cable** — 4 meter. Order 012-0630-02 ..... **$115**

***75 Ω Coaxial Cable** — BNC Connectors 42 inch, for hard copy unit. Order 012-0074-00 ..... **$17**

***75 Ω Coaxial Cable** — BNC Connectors 120 inch, for hard copy unit. Order 175-2753-00 ..... **$23**

***91AE04A Threshold Jumper Cable** — connects to 0.025 inch square pins, 3.5 inch. Order 195-0693-00 ..... **$1.30**

***91A24/91AE24 Jumper Cables** — Package of 7, twisted pair, 2 position conector, 3 inch.
Order 175-8167-00 ..... **$4.80**

A

A. 8K RAM Pack — With lithium iodide battery back up, used with 1240 12RS01 ..... **$300**

B

B. 32K EPROM Pack — Used with 1240, EPROMs not included 12RS11 ..... **$85**

C

C. Tape Cartridges, DC 100 Type — Package of 5 used on DAS 9100 Opt 01. Order 119-1350-01 ..... **$120**

D

D. 32K EPROM Pack — Used with 1240,four 68764 EPROMs included 12RS12 ..... **$300**

***Mnemonic Conversion Tape, DAS 9100** — converts mnemonic and all type files from DAS firmware versions 1.05 and 1.07 to compatability with DAS firmware versions 1.09 or 1.11.
Order 062-6705-00 ..... **$75**

***DAS 9100 Operators Manual**

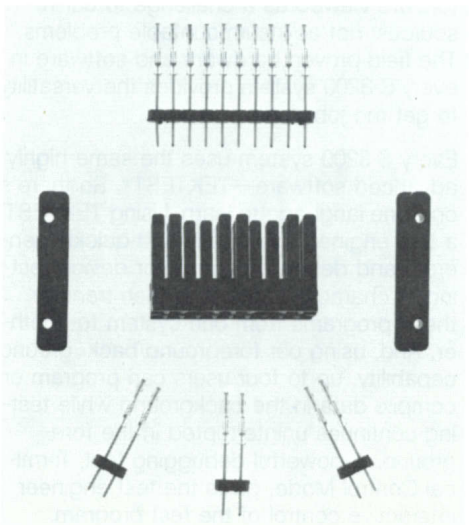
***DAS 9100 Service Manuals Vol.I and II**

***DAS 9100 Setup and Hold Time Test Fixture** —
Order 067-1037-00 ..... **$1,200**

***DAS 9100 High Speed Acquisition Test Fixture** —
Order 067-1139-00 ..... **$250**

***DAS 9100 Service Maintenance Kit** —
Order 067-0980-00 ..... **$1,250**

Accessory Pouch — Convenient for carrying manuals, probes and all accessories for 1240 and DAS 9100 logic analyzers
Order 016-0707-00 ..... **$60**



E

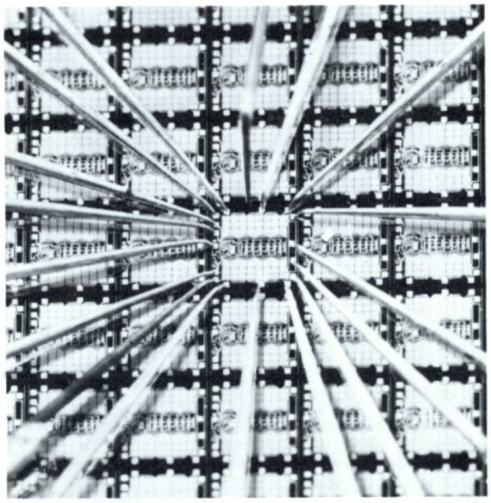
E. Circuit Board Mounted Probe Connector Kit — 10 +6 wide comb to 0.025 inch square pins on 0.15 inch centers, with mounting tabs, for PC mounting, interfaces to the following probes: P6452, P6455, P6456, P6457, P6460, and P6462.
Order 020-1027-00 ..... **$35**

Footnote
** Not Illustrated*

SEMICONDUCTOR TEST SYSTEMS

CONTENTS

S-3295 VLSI Test System 89
S-3220 LSI Test System 90
S-3275 LSI/VLSI Test System 91
S-3270 LSI Test System 92
S-3280 ECL Test System 93



At Tektronix, we've been planning for the future for years. Since the early 70's Tektronix has designed and built semiconductor test systems that have more than kept pace with the rapidly advancing semiconductor device technology. We knew that it would become increasingly difficult to test these new devices with their increased complexity, speed, and pin count, and that functional testing would become more and more important to the success of the semiconductor electronics industry.

Our testing technology has progressed in advance of industry need. Marking the beginning of Tektronix' state-of-the-art test-technology development, the first S-3200 system was designed to characterize and test LSI devices and microprocessors. Subsequent systems provided improved device characterization and were designed for quality control in production test environments. Then we tackled the challenge of testing high-speed logic devices and solving unique problems associated with subnanosecond technologies. Our testing expertise has advanced so rapidly, in fact, that we have announced six new S-3200 Series systems in the past five years—a phenomenal pace unmatched in the semiconductor test industry. All of our test systems, from the first system to the evolution of our S-3295, are backed by over a decade of reliable performance.

Tektronix provides the hardware, software, training, and applications support to solve today's testing problems, and tomorrow's as well. New and unusual device parameters are viewed as a challenge to our resources, not as insurmountable problems. The field-proven hardware and software in every S-3200 system provides the versatility to get the job done.

Every S-3200 system uses the same highly advanced software—TEKTEST®. So there's only one language to learn. Using TEKTEST, a test engineer can easily and quickly generate and debug programs for device testing or characterization and then transfer these programs from one system to another. And, using our foreground/back- ground capability, up to four users can program or compile data in the background while testing continues uninterrupted in the foreground. A powerful debugging tool, Terminal Control Mode, gives the test engineer interactive control of the test program.

All of the S-3200 systems feature highly sophisticated data reduction and graphics, which make the test results manageable and easy to understand.

We offer analog and digital capability to meet the unique test requirements presented by new and increasingly complex devices. In fact, most manufacturers of captive devices use Tektronix systems for just this reason. Tektronix is also a device manufacturer and has been testing its own ICs and hybrids for years. We have developed expertise and in-depth understanding of complex testing.

At Tektronix, we've built on our past experience and knowledge about device testing to create a total, compatible line of LSI/VLSI test systems that can help solve your test problems — today and in the future.

S-3295

State-of-the-Art Performance in VLSI Development and Evaluation

256 Channels, 128 I/O Pins

State-of-the-Art Driver/Receiver

Programmable Dynamic Loads

128 Kilobit Local Pattern Memory

Automatic De-Skew

DEC PDP-11/44 CPU

Dynamic Time-Set Selection

Advanced Color Graphics and Data Reduction

TEKTEST V, an RSX-11M Based, Super Enhanced TEKTEST Language and User Interface

To Meet Your Changing Test Requirements—Tektronix Announces Tomorrow's Solution

State-of-the-art yesterday, today, and tomorrow. From simple to complex, small scale integration to very large scale integration, common integrated circuits to microprocessors, the evolution of Tektronix systems continues to meet your test needs. Tektronix semiconductor test systems not only keep pace with what you're developing today, but also provide solutions for the test requirements of the future. The Tektronix S-3295 is the newest generation in our system technology evolution developed to handle tomorrow's complex, high pin count devices.

The S-3295 was designed to meet VLSI engineering evaluation needs in the computer, aerospace, and telecommunications industries, as well as in semiconductor manufacturing. The S-3295 is yet another industry-leading step forward for the S-3200 Series. It offers significant performance increases in real-time pattern generation/recognition, timing flexibility/accuracy, resolution, and functional pin capability. This system supports 256 independent pins (128 I, 128 O), offering greater capacity and flexibility in accommodating high pin count devices.

Subsystems within the S-3295 include the Pattern Processor, with its unique and powerful capabilities, and the Clock Generator, which provides 16 sets of 16 timing phases, accurate 125 ps edge-timing resolution, and split-cycle operation at all clock speeds. These two subsystems provide uncompromised 20 MHz test rates within the S-3295.

The S-3295 has been redesigned with all new high performance pin electronics drivers and receivers. The new pin electronics cards provide increased capabilities and performance in driver and comparator formatting, clock phase distribution, signal transition times, and edge position accuracy for optimized fidelity at high speeds. Automatic de-skew of driver, comparator, and inhibit phase circuits enhance measurement certainty. Programmable dynamic loads eliminate complex load boards. Local pattern memory of 128 kilobits per I/O pin can accommodate very large patterns and minimize CPU transfers. Data and clock channel multiplexing provides 40 MHz real-time functional data rate on a reduced set of pins. A DEC (Digital Equipment Corporation) PDP-11/44 offers up to 4 megabytes of main memory. Color graphics enable easier reporting and interpretation of engineering data.

The S-3295 is based on the proven S-3200 architecture that has been delivering test results worldwide over the last decade. Proven features like S-STMS (Single-Shot Time Measurement Subsystem), 50-ohm switching matrix, a waveform digitizer, optional stimulus and measurement subsystems (GPIB instrumentation), and compatible peripherals. And the S-3295 features TEKTEST V, an RSX-11 M based, super enhanced software language and user interface. TEKTEST is the industry leader in test languages for engineering evaluation and characterization. Tektronix is committed to hardware and software compatibility.

Device technology is changing—the new Tektronix S-3295 System meets these changes head-on.

S-3220

Full Capability 20 MHz Test System

Vertically-Oriented Pin Electronics Simplifies Prober/Handler Interface

Minimal Floor Space Requirements

Cost-Effective for High-Throughput Production Applications

Enhanced 1 k Pattern RAM Supplements 4 k per Pin Stored Memory

Single-Shot Timing Measurement

Uses TEKTEST®, Allowing Device Characterization Programs to be Condensed and Used in Production Testing

Up to 128-Pin Test Capability

The Tektronix S-3220 is a versatile computer-controlled automated test system designed for testing and verifying the performance of the wide variety of integrated circuits in use today. The S-3220 is an ideal test system for users with requirements that range from SSI through LSI. In addition to high-speed digital circuits, this system accommodates analog devices and dual-family hybrids such as CODECs and ADCs.

The S-3220 is offered as a production-oriented complement to the Tektronix S-3270 Test System. Since the S-3220 uses the TEKTEST control software used in all S-3200 systems, programs originally developed for engineering use can easily be condensed and employed in a high volume production or incoming inspection environment. The essential test related features of the larger systems are retained in the S-3220, allowing (with no loss in speed or accuracy) functional or pattern testing as well as dc parametric and single-pass ac parametric testing.

The S-3220 is the first S-3200 Series system with a vertical pin-electronics package that is integrated with the control/stimulus equipment rack. This feature eases prober/handler mechanical interface and reduces floor space requirements — an important consideration in most production areas.

S-3275

Independent I/O Control on a Cycle-by-Cycle Basis at Each Pin

16 Programmable Driver/Compare Phases

16 Programmable Timing Sets, Each Available on a Cycle-by-Cycle Basis (Split-Cycle)

Full Functional Data (Force, Inhibit, Compare, Mask) to All Pin Electronics Cards at 20 MHz Test Speed

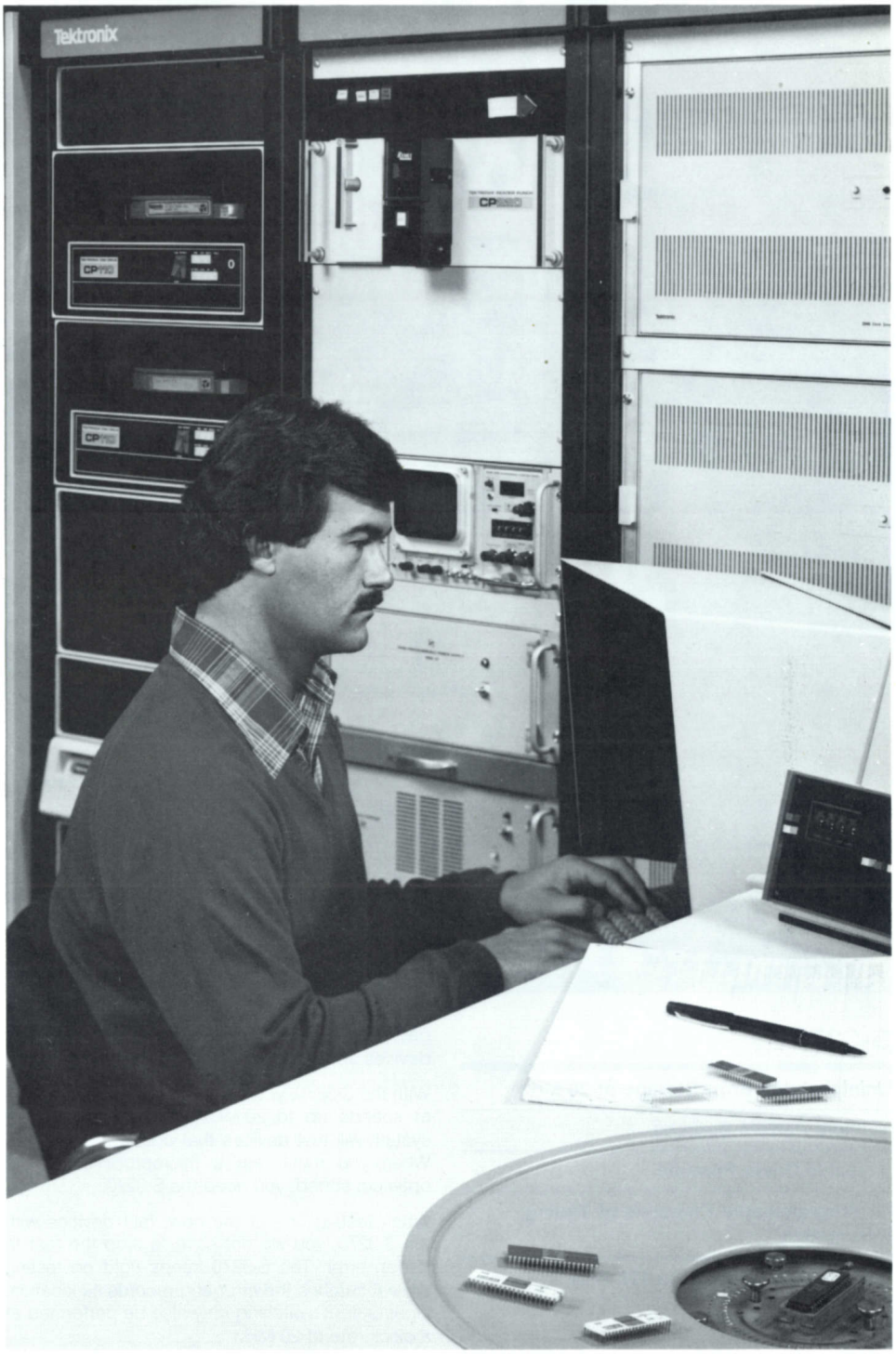
Versatile Driver Formats

Tests Devices With Up to 128 Pins

Single-Shot Timing

Advanced Graphics and Data Reduction

Uses TEKTEST®, a Device-Oriented Test Language With Networking Capability



Using a powerful set of testing features, the S-3275 is more than able to measure the characteristics of today's complex LSI/VLSI devices, single-chip microcomputers, 16-bit processors, memories, hybrids, analog LSI and others. The S-3275 gives both the speed and data width demanded by such devices, and combines them with advanced software for effective data management and control.

An integral part of the S-3275, the Pattern Processor can send all four data bits to each pin-electronics card during each test cycle. These four bits (force, inhibit, mask, and compare) provide nine distinct test states to each pin card resulting in 64 inputs and 64 outputs at clock rates up to 20 MHz for true 128-pin test capability.

It combines the functions of pattern sequencing and algorithmic pattern generation. As a pattern processor, it allows sophisticated control of pattern sequence programming. Loops, subroutines, conditional branching, nesting, and list pointers can all be used to control program flow. Interrupts can be initiated from a number of sources to start new pattern sequences (and then return to the original). Phantom clock cycles can be invoked to execute multiple processor steps during a single cycle at the test head.

In the algorithmic pattern generation mode, the processor controls the output of the X and Y address generators, each 12 bits wide. This address output may then be scrambled by a 4 k topological memory. A 12-bit control (Z-axis) generator provides signals to manipulate control lines to the device under test. A data generator produces 16 force data bits and 16 compare data bits. Refresh algorithms are initiated by interrupts to the pattern controller.

The Clock Generator is also part of the system and exhibits performance to match almost any testing requirement. Cycle periods range from 500 Hz to 20 MHz, with time resolution to 8 ns. Up to 16 phases are available during each cycle, with a phase-edge resolution of 125 ps and a pulse width down to 4 ns. 16 sets of these phases can be programmed and then selected on a cycle-by-cycle basis during testing. The clock can be operated in a free-running mode, or synchronized to a signal from the device under test. These two modes are interchangeable from one test cycle to the next.

S-3270

Uninterrupted Error Storage at 20 MHz

Multiple Pattern Sources

Versatile Driver Formats

14 Programmable Channels of Timing Information

Test Devices With Up to 128 Pins

Single-Shot Timing

Advanced Graphics and Data Reduction

Uses TEKTEST®, a Device-Oriented Test Language

Easy to Program and Edit

True Foreground/Background Timesharing

The S-3270 system tests LSI, microprocessors, analog and digital hybrids, peripheral interface circuits, RAMs, ROMs, and more. Designed to deliver test results on the devices you see every day. It is also built to deliver results when new devices appear.

With the S-3270, you can perform functional tests at speeds up to 20 MHz. In some cases, the system will test devices that operate at 40 MHz. When you must test a microprocessor at its optimum speed, you need the S-3270.

When testing one of the new, fast devices with the S-3270, you will not have to stop the test to log an error. The S-3270 keeps right on testing while it catches the error and records its location. Input/Output switching may also be performed at a clock rate of 20 MHz.

The fully integrated waveform digitzer allows you to perform linear and analog tests. The system has 64 pin-electronic cards, each with input and output capability, so you can test a device with up to 128 pins. The 14-phase clock gives you many programmable channels of timing information, to properly and effectively test devices.

For total flexibility, the S-3270 features independent control of logic level definition at each driver and receiver. You set the logic level on every input and output channel, so you are not bound by the limits of the system.

When device complexity dictates highly advanced patterns, the S-3270 gives you multiple ways to produce those patterns — programming on the disk or mag tape, toggling, using the 2942 Memory Pattern Generator, the PRAM and/or shift registers. The S-3270 is equipped with 4 k of shift register memory behind each pin, and it can be increased to 8 k of memory.

High Performance Drivers (30 V swing) Allow Versatility in Testing

The unique Single-Shot Time Measurement technique allows you to make a measurement with 50 ps resolution in one iteration. Dynamic measurements can also be made by moving strobes (iteration) or by using the optional waveform digitizer.

The basic system makes differential voltage measurements on your device with a resolution of 50 μV. It also features sub-nanoamp current measuring, especially important in testing CMOS devices. Kelvin sensing increases the accuracy of the forced voltage, insuring that the levels at the DUT will be exactly what you ordered.

When you are characterizing devices that are fast, complex, and unfamiliar, you need a system that is both capable and flexible, the Tektronix S-3270.

S-3280

- 100 k ECL Testing
- Precision Fixturing
- Subnanosecond Measurements
- Full Graphics and Data Reduction Package
- High-Speed Drivers
- Sampling for Waveform Analysis
- Uses TEKTEST®
- Simple to Program and Edit
- Tests High-Speed Logic
- CML Capability

Testing subnanosecond logic devices requires extremely fast pulses, clean edges, precise control of pulse levels, and highly accurate time measurement capability. The S-3280 is designed to meet the testing requirements of high-speed logic devices.

This system is based on the proven architecture of the Tektronix S-3200 LSI test systems. The S-3280 has the same advanced pattern generation capability and features multiple pattern sources, from algorithmic patterns to memory patterns to simple fixed or toggled bits. The S-3280 also features a 20 MHz data rate with interrupted error storage at that speed. Like all other S-3200 systems, the S-3280 uses a device-oriented, English-like test language, TEKTEST.

The S-3280 was designed specifically to solve ECL testing problems. Featuring subnanosecond time measurement capability, the high-speed hardware gives the S-3280 the ability to test ECL devices to their fullest.

One of the more important features of an ECL test system is its ability to make accurate timing measurements. The S-3280 features three methods of making dynamic measurements. First, Delta-T provides measurements with 50 ps resolution on any test vector, at 20 MHz data rate, in a single pass. Second, our Waveform Digitizing (sampling) capability provides 1 ps resolution to digitize and store any waveform for further analysis. Third, for functional testing, the system's strobed comparators will make tests on any or all test vectors at 20 MHz. The system features 1 mV programming resolution with dual-level comparators on every channel.

Because no multiplexing is necessary the system uses the shortest possible path to deliver clean, accurate signals to the device, thus minimizing waveform degradation.

The S-3280 will measure the parameters of today's ECL devices and will continue to be able to test the more advanced high-speed logic devices that are being developed. The S-3280's advanced, high-speed measurement characteristics make it a superior ECL testing solution.

Training and Support

When you purchase a Tektronix S-3200 Semiconductor Test System, we want you to be able to use that system to the fullest extent of its capabilities. We have an entire support staff dedicated to helping you do just that. And an integral part of that support is our professional training for your test engineers and service technicians. Before you purchase a system, a training specialist works with you and your Tektronix Sales Specialist to identify your training requirements and recommend an appropriate training schedule.

With the purchase of your system, you receive credits for up to ten weeks of training in our S-3200 System Basic Applications and Basic Maintenance classes. We also offer advanced training in test applications and maintenance as well as tailor-made training seminars in special interest areas. Additional training credits for the basic courses may be purchased to allow for staff expansion and turnover.

The courses are fast-paced, performance-oriented, and individualized. Instruction time in all classes is equally divided between classroom lecture and hands-on laboratory experience. Each student is expected to choose specialized lab projects which will meet individual job requirements, so your unique system applications become the focus of training.

Our instructors have extensive experience in test system applications and maintenance. And they stay abreast of modern instructional techniques, advanced system applications, and hardware operation. Class size is limited to maintain a balance of one instructor for every four students during lab sessions.

For further information on class schedules, course content, or your special training requirements, contact your Tektronix Sales Specialist or the STS Training Coordinator at (503) 629-1187.

TEKTEST Software

The language of S-3200 Series systems, TEKTEST, is a device-oriented language, easy to read and understand since it is very close to English. System architecture was designed so that programming, editing and debugging all use TEKTEST. When making corrections in a program, there is no need to use a "bridge" language between the source language and the machine language. Everything is written in TEKTEST. This capability, that we call Terminal Control Mode, gives the test engineer total control of the program. When editing program material during a test, the test engineer can hold power to the device, make the changes, and continue the test. There is no need to re-sequence the program. And, since these systems also feature true foreground/background operation, up to four test engineers can be using terminals interfaced to a system, and the system will continue to test devices without any throughput loss. Terminal Control Mode and true foreground/background make the S-3200 Series simple and fast to program and debug.

The more complex a device, the more information you need about that device. But with complexity can come confusion...unless your test system makes the picture clearer.

The S-3200 Series systems provide you with the graphics capability to reduce testing data to manageable, usable form.

For More Information

For more information about the S-3200 Semiconductor Test Systems, contact the Test Systems Specialist located in the office nearest you.

Portland, OR

Boston, MA

Philadelphia, PA

DC Md

St. Louis, MO

Tektronix Australia
Melbourne, Australia

Tektronix Brazil
Sao Paulo, Brazil

Tektronix U.K., Ltd.
Harpenden, England

Tektronix
Orsay, France

Tektronix AB
Solna, Sweden

Tektronix Holland, B.V.
Badhoevedorp, The Netherlands

Tektronix GmbH.
Munich, West Germany

Sony/Tektronix Corporation
Tokyo, Japan

Tektronix Canada, Inc.
Montreal, Canada

Tektronix Europe B.V.
Amstelveen, The Netherlands

INFORMATION DISPLAY DIVISION

A series of new product concepts and recent technological breakthroughs have expanded the spectrum of Tek's computer graphics products. Our hardware and software products are built to enhance the practicality, productivity and value of computer graphics in many environments. For the first time, a broad range of compatible color and monochrome products in both raster and DVST technologies permit the optimum match of graphics tools to the task from text editing to the most demanding CAD/CAM applications. Tektronix has set the graphics standard by providing the most reliable line of graphics tools in the business.

COMPUTER GRAPHICS PRODUCTS

CONTENTS

4105 Computer Display Terminal 98
4107 Computer Display Terminal 99
4109 Computer Display Terminal 100
4170 Local Graphics Processing Unit 101
4695 Color Graphics Copier 102
4691 Color Graphics Copier 103
4115B/M4115B Computer Display Terminals 104
4112B Computer Display Terminal 106
4113B/4113B30 Computer Display Terminals 107
4114B/4114B30 Computer Display Terminals 108
4116B/4116B30 Computer Display Terminals 109
4925/4926 Disk Drives 110
4970 Cluster Controller 111
Software 112-121
4006-1 Computer Display Terminal 122
4012 Computer Display Terminal 122
4014-1 Computer Display Terminal 123
4016-1 Computer Display Terminal 124
4025A Computer Display Terminal 125
4027A Color Graphics Terminal 125
614, 616, 618 Storage Display Monitors 126
4051 Desktop Computer 128
4052A Desktop Computer 129
4054A Desktop Computer 130
4907 File Manager 131
4924 Digital Cartridge Tape Drive 131
4932 GPIB Extender 132
4909 Multi-User File Management System ... 132
4611/4631 Hard Copy Units 133
4612/4632 Video Hard Copy Units 134
4634 Imaging Hard Copy Unit 135
4643 Matrix Printer 135
4662-31 Interactive Digital Plotter 136
4663, 4663S Interactive Digital Plotter 137
4952 Joystick 138
4953/4954/4956/4957 Graphic Tablets 138
4635 Imaging Recorder 139
OEM Display Products 140
634 High Resolution Video Monitor 141
690SR Color Display Monitor 141
620/606B Display Monitors 142
608/624 Display Monitors 143
GMA 102A/GMA 103 Display Modules 144
GMA 125 Display Module 145
Computer Graphics Supplies 146

"The Graphics Standard"

Tektronix has an ongoing commitment to customers, offering them not only the highest quality but the most technologically advanced products. This year we have expanded our line of color raster display terminals to include a sophisticated high-end color graphics terminal, the 4115B (shown at right). And we've added a new family of low cost yet high performance terminals — the 4105, 4107 and 4109. This new family uses the latest technology to combine VT100 text editing with Tektronix color graphics. Our goal is to make available, to the widest audience possible, the distinct advantages of color graphics.

These new products complement a broad line of graphics equipment including graphics software, color and monochrome display terminals, desktop computers, hard copy units and peripherals.

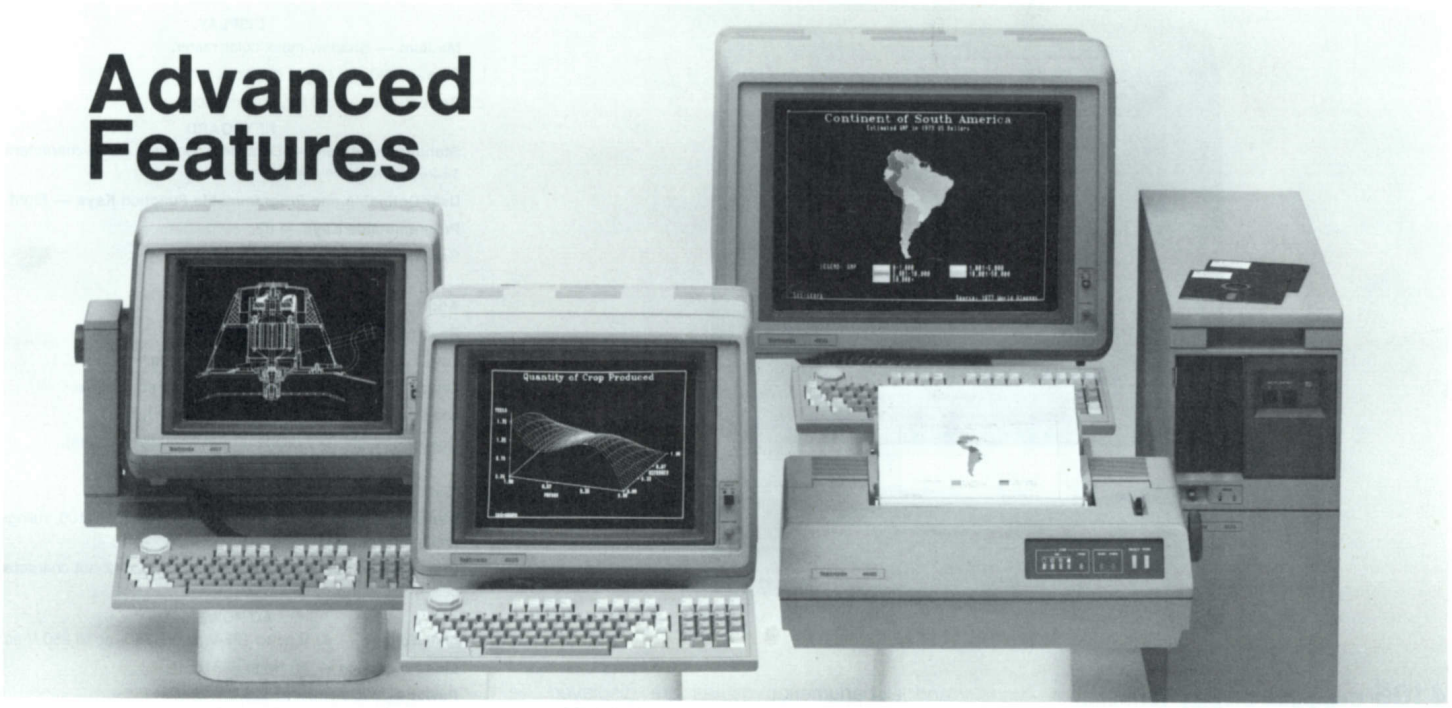
Tektronix offers service training classes on the products listed below. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.

4025A, 4027A, 4052A, 4054A, 4051, 4907, 4662, 4663, 4112B, 4113B, 4114B, GMA 101, GMA 102A, GMA 103, GMA 125, 4014, 4631.

NEW

COLOR DISPLAY TERMINALS

Advanced Features



The new 4105, 4107, 4109 and 4115B Color Display Terminals Yield Increasing Degrees of Resolution and Graphics Sophistication
There is now a Tektronix color graphics terminal to fit virtually any application need or budget. And all of the new 4100 Series terminals are fully compatible with Tektronix 4010 Series and the 4110 Series terminals, as well as with an extensive library of Tektronix software.

A new local graphics processing unit, the 4170, brings local intelligence and graphics processing to the 4100 Series terminals, giving them independence from the host computer and cutting communication costs and response times.

Extended-capability features found in many of the new terminals include local picture segments, two dimensional image transformation, true zoom and pan, multiple viewports, multiple bit planes, overlays and autoconvergence.

Local Picture Segments
A local picture segment is a user-defined picture or set of symbols stored in local memory as a unique graphic element. A single command to the host can recall and redraw a picture segment without transmitting the entire sequence of graphics data that originally went into composing the picture. The result—a significant decrease in host-terminal traffic and response time. This local picture segment capability is found in the 4107, 4109 and 4115B terminals, each with increasing amounts of local random access memory (RAM).

Two Dimensional Image Transformation
The local 2-D image transformation capability allows a local picture segment displayed on a 4110 Series terminal to be rotated, translated (shifted in position), and scaled (expanded or contracted) with a single command.

True Zoom and Pan
The local picture segment capability makes possible another important graphics feature in some 4100 and 4110 Series terminals: true zoom and pan. True zoom allows the user to isolate and magnify any section of the device coordinate space.

Unlike pixel replication, which simply enlarges the picture without providing additional detail, true zoom significantly increases resolution. The terminal actually recomputes the coordinate information of the designated area in order to display details that were not visible in the "panoramic" view.

Multiple Viewports
The 4115B joins the existing 4110 Series terminals in offering multiple viewports. On command from the host, the 4115B display can be split into a number of viewports (a defined area in raster memory), each corresponding to a defined "window" in the device coordinate space. Up to 64 viewports can be displayed simultaneously. Multiple viewports enable the user to display several views of related information on the screen at the same time for comparison and reference.

Multiple Bit Planes
A bit plane is a defined area of raster memory space, with each binary bit of memory corresponding to a pixel on the display. The more bit planes, the greater a terminal's ability to display color combinations and to create separate "surfaces" on the terminal screen.

The 4115B is capable of displaying 256 colors at one time from a palette of 16 million colors; the 4109, 16 colors from a palette of 4096; the 4107, 16 colors from a palette of 64; and the 4105, 8 colors from a palette of 64. Many applications require such color variety to generate real images, to smooth diagonals while maintaining clarity and to show subtle, qualitative changes.

Overlays
The eight bit planes in the 4115B allows the user to create up to eight separate "surfaces" or distinct display areas. The user can draw a different picture on each surface, then overlay the surfaces to create new views of related information.

Autoconvergence
The 4115B contains a first-of-its-kind convergence feature that automatically corrects the natural drift occurring in the convergence of the color raster writing beams. Convergence is controlled to within 0.2 mm over the entire display area, resulting in sharper characters, lines and colors. Technical skills are not required to maintain optimum convergence.

Product overviews and specification data follow. In many cases, factors such as ergonomics and display quality are best seen to be fully appreciated. We invite you to ask your local Tektronix Sales Engineer for a demonstration. Or, simply indicate your interests on the enclosed reply card.

NEW

COLOR DISPLAY TERMINAL

4105 Computer Display Terminal

Low-Cost, High-Quality Color Graphics and Alphanumerics

Supported by a Push-button Color Copier and a Local Graphics Processing Module

Compatible with Tek 4010, 4100 and 4110 Series Terminals

Operates in IBM SNA Environments with the 4970 Cluster Controller

One Year On-Site Warranty—Three Year Option

The Tek 4105 is a Color Raster Display Terminal Designed to Bring Color Graphics and Alphanumeric Capabilities Within Easy Reach of Every Technical Professional

Excellent display quality and ergonomic design facilitate easy creation and editing of color graphics and color text. Flicker-free 60 Hz noninterlaced refresh rate; precision in-line gun with fixed convergence, and antiglare etched screen combine to optimize the clarity and brightness of the terminal's 480 x 360 displayable matrix.

Windowing

Resolution is enhanced by an addressable display matrix of 4096 x 4096 points. This allows the 4105 to accept data files displayed on terminals such as Tektronix' high resolution 4114B or 4115B. The user can "window in" on any portion of the matrix, and by retransmitting the data from the host, display the selected window with significantly greater detail.

In the graphics mode, the user can access up to eight colors selected from a palette of 64. Colors may be changed locally by using the friendly color user interface. Text may also be specified in as many as eight colors; up to 16 colors may be on-screen simultaneously when both the graphics and alphanumerics planes are displayed. Text editing is in compliance with ANSI X3.64 standards for screen editors.

The alphanumerics surface can be used to display host communications without interfering with the graphics on-screen.

Ergonomic Design

The 4105 features a low-profile, detached DIN standard keyboard with complete ASCII characters. Integral to the keyboard is an innovative Joydisk for positioning the crosshair cursor or scrolling text in the dialog area. The 4105 can be mounted on an adjustable stand that allows it to be easily tilted up or down, swiveled left or right, lowered or elevated, or moved forward and back.

The 4105 will accept existing programs written for Tek 4010 Series terminals. Programs written for the 4105 are upwardly compatible with the other 4100 desktop terminals and with the 4110 Series terminals. The 4105 is compatible with the Tektronix PLOT 10 Interactive Graphics Library (IGL) and PLOT 10 Easy Graphing II.

A number of plug-compatible peripheral devices further extend the value and versatility of the 4105. These include the 4695 Color Graphics Copier (for high-quality color hard copy), the 4170 Local Graphics Processor (for off-line use of the 4105) and the 4970 Cluster Controller (for operation in synchronous IBM SNA environments).

Our new 4100 Series color terminals are so reliable, the 90-day industry expected warranty just doesn't apply. Instead, they are covered by a new on-site service warranty for one full year. What's more, we're so confident of the 4100 Series reliability, that we'll extend your coverage through the second and third years of ownership for price so low that it breaks industry barriers.

CHARACTERISTICS

DATA TRANSMISSION

Data Rate — Up to 38.4 kbaud.

Communications Interface — RS-232C.

DISPLAY

Medium — Shadow-mask color raster.

Size — 330 mm (13 in) diagonal.

Refresh Rate — 60 Hz, noninterlaced.

KEYBOARD

Standard Keyboard — Detached, complete ASCII characters, 14-key numeric keypad.

User Definable and Programmable Function Keys — Eight.

Programmable Keys — 82.

Graphic Cursor Control — Joydisk.

GRAPHICS MODE

Addressability — 4096 x 4096 points.

Resolution — 480 x 360 pixels.

Line Types — Solid, seven dashed types.

Graphic Command Syntax — PLOT 10 compatible.

Graphics Primitives — Vectors, polygons, text.

Colors — Eight (independent of alphanumeric colors).

ALPHANUMERIC MODE

Primary Character Set — 94 (full ASCII).

Alternate Character Set — 94 (International, VT-100, rulings and mathematics).

Character Format — 5 x 9 dot matrix in 6 x 12 dot character cell.

AC POWER

Line Voltage — 87 V ac to 128 V ac or 174 V ac to 250 V ac.

Line Frequency — 48 Hz to 66 Hz.

Power — 200 W max at 125 V.

PHYSICAL CHARACTERISTICS

Dimensions	Module		Keyboard	
	mm	in	mm	in
Width	419	16.5	423	16.6
Height	353	13.9	41	1.6
Depth	495	19.5	180	7.0
Depth (with cables)	572	22.5		
Weights	**kg**	**lb**	**kg**	**lb**
Net	20.0	44.0	11.0	5.0

INCLUDED ACCESSORIES

8 ft power cord; 12 ft host port RS-232 cable (012-0911-00); pkg of 6 keyboard overlays (334-5164-00); standard keyboard (119-1592-00); operators manual; programmer's reference manual; reference guide.

ORDERING INFORMATION

4105 Computer Display Terminal **$3,995**

Option 4A — United Kingdom Keyboard ..... **NC**
Option 4B — French Keyboard ..... **NC**
Option 4C — Swedish Keyboard ..... **NC**
Option 4F — Danish/Norwegian Keyboard ..... **NC**
Option 4G — German Keyboard ..... **NC**
Option 4K — Japanese (Katakana) Keyboard ..... **+$120**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

WARRANTY PLUS SERVICE PLAN REFER TO PAGE 41

N2 — Service Plan +2 Years Service ..... **+$195**

OPTIONAL ACCESSORIES

RS-232 Loopback Connector —
Order 067-1042-00 ..... **$13**
Copier Port Loopback Connector —
Order 013-0214-00 ..... **$20**
Graticule — Order 067-1150-00 ..... **$145**
Service Manual

COMPANION PRODUCTS

ADS01 — Adjustable Display Stand Provides Tilt, Swivel, Elevate and Glide Adjustments **$395**
4695 — Color Graphics Copier **$1,595**
4170 — Local Graphics Processing Unit **$5,500**
4970 — Cluster Controller **$5,100**

See this color product in the reference section beginning on page 9.

OEM terms available on this product.

NEW

COLOR DISPLAY TERMINAL

4107 Computer Display Terminal

Low-Cost, High-Performance Color Graphics and Alphanumerics

Supported by a Push-button Color Copier and Local Graphics Processing Module

Compatible with Tek 4010, 4100, and 4110 Series Terminals

Operates in IBM SNA Environments with the 4970 Cluster Controller

One Year On-Site Warranty—Three Year Option

The Tek 4107 is a Color Raster Terminal that Rivals Much More Costly Displays in Resolution, Reliability, Alphanumerics Capability, and Local Graphics Manipulation

Excellent display quality and friendly input interface facilitate easy creation and editing of color graphics and color text. Flicker-free 60 Hz noninterlaced refresh rate and shadow mask color CRT combine to optimize the clarity and brightness of the terminal's 640 x 480 displayable matrix.

The resolution is enhanced by an addressable display matrix of 4096 x 4096 points. To view a section in greater detail, the user zooms in on a portion of the display and the 4107 recomputes the coordinate information to display the designated section. Rather than "pixel replication" that simply enlarges the picture without providing additional detail, this true zoom significantly increases resolution.

Up to 128 k of RAM Permits Picture Elements to be Locally Stored, then Redrawn and Manipulated as Necessary

Users can develop symbols and picture segments pertinent to the application, and recall them saving transmission and CPU time, thus improving interactivity.

The user can select up to 16 colors on the graphics plane from a total palette of 64 colors. Colors can be changed locally by using the friendly interface to the color map. Text may also be specified in as many as eight colors. Text editing is in compliance with ANSI X3.64 standards for screen editors.

Alphanumeric information is displayed on a separate surface that can be used to display host communications without interfering with the graphics on-screen.

Ergonomic Features

Designed for comfort and convenience, the 4107 has a low profile, standard DIN detached keyboard with complete ASCII characters. Integral to the keyboard is an innovative Joydisk for positioning the crosshair cursor or scrolling text in the dialog area. In addition, the 4107 can be mounted on an adjustable stand that allows the terminal to be easily tilted up or down, swiveled left or right, lowered or elevated, or moved forward and back. The 4107 will accept existing programs written for Tek 4010 Series terminals and is upwardly compatible with programs for 4100 and 4110 Series terminals. It is compatible with the Tektronix PLOT 10 IGL (Interactive Graphics Library) and with PLOT 10 Easy Graphing II. The 4107 allows for a smooth transition to higher-end terminals as application needs change.

A Number of Plug-compatible Peripheral Devices Further Extend the Value and Versatility of the 4107

These include the 4695 Color Graphics Copier (for a high quality color hard copy), the 4170 Local Graphics Processor (for off-line use of the 4107) and the 4970 Cluster Controller (for operation in synchronous IBM SNA environments).

Our new 4100 Series color terminals are so reliable, the 90-day industry expected warranty just doesn't apply. Instead, they are covered by a new on-site service warranty for one full year. What's more, we're so confident of the 4100 Series reliability, that we'll extend your coverage through the second and third years of ownership for a price so low that it breaks industry barriers.

CHARACTERISTICS

DATA TRANSMISSION

Data Rate — 38.4 kbaud.

Communications Interface — RS-232C.

DISPLAY

Medium — Shadow mask color raster.

Size — 330 mm (13 in) diagonal.

Refresh Rate — 60 Hz, noninterlaced.

KEYBOARD

Standard Keyboard — Detached, complete ASCII characters, 14-key numeric keypad.

User Definable and Programmable Function Keys — Eight.

Programmable Keys — 82.

Graphic Cursor Control — Joydisk.

GRAPHICS MODE

Addressability — 4096 x 4096 points.

Resolution — 640 x 480 pixels.

Line Types — Solid, seven dashed types.

Graphic Command Syntax — PLOT 10 compatible.

Colors — 16.

Palette Selection — 64.

ALPHANUMERIC MODE

Primary Character Set — 94 (full ASCII).

Alternate Character Set — 94 (International, VT100, rulings and mathematics).

Character Format — 7 x 9 matrix in 8 x 14 dot character cell.

AC POWER

Line Voltage — 87 V ac to 128 V ac or 174 V ac to 250 V ac.

Line Frequency — 48 Hz to 66 Hz.

Power — 200 W max at 125 V.

PHYSICAL CHARACTERISTICS

Dimensions	Module		Keyboard	
	mm	in	mm	in
Width	419	16.5	423	16.6
Height	353	13.9	41	1.6
Depth	495	19.5	180	7.0
Depth (With Cables)	572	22.5		
Weights	**kg**	**lb**	**kg**	**lb**
Net	20.0	44.0	2.3	5.0

INCLUDED ACCESSORIES

8 ft power cord (161-0066-00); 12 ft host port RS-232 cable (012-0911-00); pkg of 6 keyboard overlays (334-5164-00); standard keyboard (119-1592-00); operator's manual, programmer's reference manual, reference guide.

ORDERING INFORMATION

4107 Computer Display Terminal **$6,950**

Option 4A — United Kingdom Keyboard ..... **NC**
Option 4B — French Keyboard ..... **NC**
Option 4C — Swedish Keyboard ..... **NC**
Option 4F — Danish/Norwegian Keyboard ..... **NC**
Option 4G — German Keyboard ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

WARRANTY PLUS **SERVICE PLAN** **REFER TO PAGE 41**

N2 — Service Plan +2 Years Service ..... **+$295**

OPTIONAL ACCESSORIES

RS-232 Loopback Connector —
Order 067-1042-00 ..... **$13**
Copier Port Loopback Connector —
Order 013-0214-00 ..... **$20**
Graticule — Order 067-1150-00 ..... **$145**
Service Manual

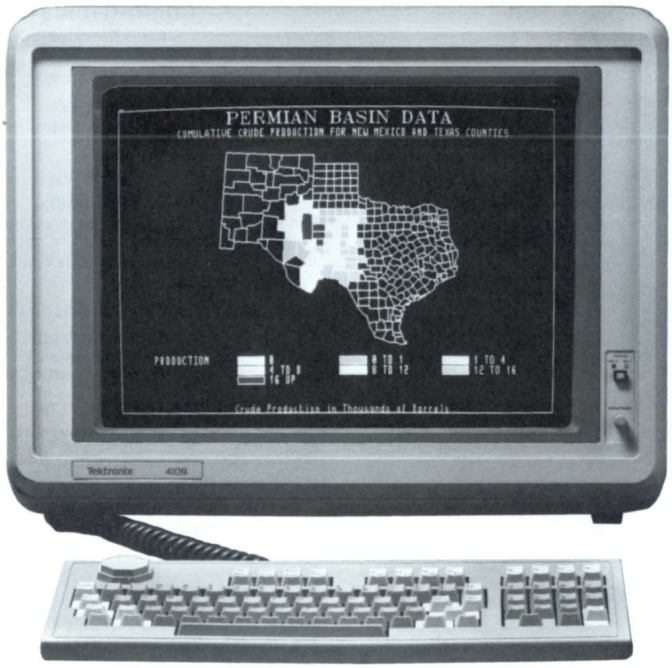
COMPANION PRODUCTS

ADS01 — Adjustable Display Stand Provides Tilt, Swivel, Elevate and Glide Adjustments **$395**
4695 — Color Graphics Copier **$1,595**
4170 — Local Graphics Processing Unit **$5,500**
4970 — Cluster Controller **$5,100**

See this color product in the reference section beginning on page 9.

NEW

COLOR DISPLAY TERMINAL



4109

Low-cost, High-performance Color Graphics and Alphanumerics on a 19 Inch Display

Select from a Palette of 4096 Colors

Supported by a Push-button Color Copier and a Local Graphics Processing Module

Compatible with Tek 4010, 4100 and 4110 Series Terminals

Operates in IBM SNA Environments with the 4970 Cluster Controller

1 Year On-Site Warranty—3 Year Option

The Tek 4109 Computer Display Terminal is a Color Raster Terminal That Rivals Much More Costly Displays in Resolution, Reliability, Alphanumerics Capability and Local Graphics Manipulation

Excellent display quality and friendly input interface facilitate easy creation and editing of color graphics and color text. Flicker-free 60 Hz noninterlaced refresh rate and shadow mask color CRT combine to optimize the clarity and brightness of the terminal's 640 x 480 displayable matrix.

Effective 4109 resolution is considerably enhanced by an addressable display matrix of 4096 x 4096 points. To view a section in greater detail, the user zooms in on a portion of the display and the 4109 recomputes the coordinate information to display the designated section. Rather than "pixel replication" that simply enlarges the picture without providing additional detail, this true zoom significantly increases resolution.

Up to 256 k of RAM Permits Picture Elements to be Locally Stored, then Redrawn and Manipulated as Necessary

Users can develop symbols and picture segments pertinent to the application, and recall them, saving transmission and CPU time, thus improving interactivity.

The user can select up to 16 colors on the graphics plane from a palette of 4096 colors. Colors can be changed locally by using the friendly interface to the color map. Text may also be specified in as many as eight colors. Text editing is in compliance with ANSI X3.64 standards for screen editors. The 4109 can display ASCII complete upper- and lower-case alphanumerics, as well as alternate character fonts.

Alphanumeric information is displayed on a separate surface that can be used to display host communications without interfering with the graphics on-screen.

Ergonomic Features

Designed throughout for comfort and convenience, the 4109 has a low profile, standard DIN detached keyboard with complete ASCII characters. Integral to the keyboard is an innovative Joydisk for positioning the crosshair cursor or scrolling text in the dialog area.

The 4109 will accept existing programs written for Tek 4010 and 4100 Series terminals, and is upwardly compatible with 4110 Series terminals. It is compatible with the Tektronix PLOT 10 IGL (Interactive Graphics Library) and PLOT 10 Easy Graphing II. The 4109 allows for a smooth transition to higher-end terminals as application needs change.

A Number of Plug-Compatible Peripheral Devices Further Extend the Value and Versatility of the 4109

These include the 4695 Color Graphics Copier (for a high quality color hard copy), the 4170 Local Graphics Processor (for off-line use of the 4109) and the 4970 Cluster Controller (for operation in synchronous IBM SNA environments).

Our new 4100 Series color terminals are so reliable, the 90-day industry expected warranty just doesn't apply. Instead, they are covered by a new on-site service warranty for one full year. What's more, we're so confident of the 4100 Series reliability, that we'll extend your coverage through the second and third years of ownership for a price so low that it breaks industry barriers.

CHARACTERISTICS

DATA TRANSMISSION

Data Rate — 38.4 kbaud.
Communications Interface — RS-232C.

DISPLAY

Medium — Shadow mask color raster.
Size — 483 mm (19 in) diagonal.
Refresh Rate — 60 Hz, noninterlaced.

KEYBOARD

Normal Keyboard — Detached, complete ASCII characters, 14-key numeric keypad.
User Definable and Programmable Function Keys — Eight.
Programmable Keys — 82.
Graphic Cursor Control — Joydisk.

GRAPHICS MODE

Addressability — 4096 x 4096 points.
Resolution — 640 x 480 pixels.
Line Types — Solid, seven dashed types.
Graphic Command Syntax — PLOT 10 compatible.
Colors — 16.
Palette Selection — 4096.

ALPHANUMERIC MODE

Primary Character Set — 94 (full ASCII).
Alternate Character Set — 94 (International, VT-100, rulings and mathematics).
Character Format — 7 x 9 matrix in 8 x 14 dot character cell.

AC POWER

Line Voltage — 87 V ac to 128 V ac or 174 V ac to 250 V ac.
Line Frequency — 48 Hz to 66 Hz.
Power — 200 W max at 125 V.

PHYSICAL CHARACTERISTICS

Dimensions≈	Module		Keyboard	
	mm	in	mm	in
Width	559	22.0	423	16.6
Height	425	16.8	41	1.6
Depth	572	22.5	180	7.0
Weight≈	**kg**	**lb**	**kg**	**lb**
Net	31.8	70.0	2.3	5.0

INCLUDED ACCESSORIES

8 ft power cord (161-0066-00); 12 ft host port RS-232 cable (012-0911-00); pkg of 6 keyboard overlays (334-5164-00); standard keyboard (119-1592-00); operator's manual, programmer's reference manual; reference guide.

ORDERING INFORMATION

4109 Computer Display Terminal **$9,950**
Option 4A — United Kingdom Keyboard ..... **NC**
Option 4B — French Keyboard ..... **NC**
Option 4C — Swedish Keyboard ..... **NC**
Option 4F — Danish/Norwegian Keyboard ..... **NC**
Option 4G — German Keyboard ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY PLUS* SERVICE PLANS REFER TO PAGE 41**
N2 — Service Plan +2 Years Service ..... **+$395**

OPTIONAL ACCESSORIES

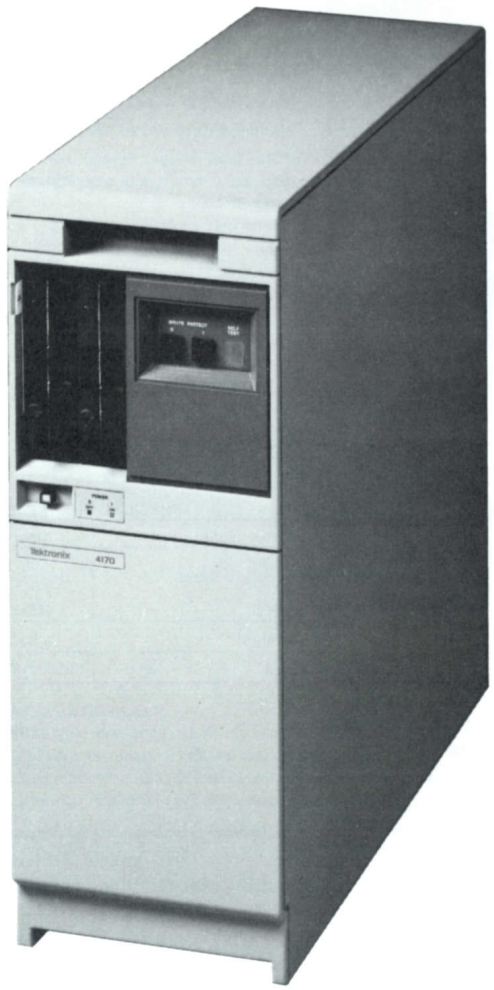
RS-232 Loopback Connector —
Order 067-1042-00 ..... **$13**
Copier Port Loopback Connector —
Order 013-0214-00 ..... **$20**
Service Manual

COMPANION PRODUCTS

4695 Color Graphics Copier **$1,595**
4170 Local Graphics Processing Unit **$5,500**
4970 Cluster Controller **$5,100**

See this color product in the reference section beginning on page 9.

OEM terms available on this product.



4170 Local Graphics Processing Unit

Provides Local Intelligence and Graphics Processing to 4100 Series Desktop Terminals

Upward-Compatible with 4110 Series Terminals

The Tektronix 4170 is a Local Graphics Processing Unit that Provides the 4105, 4107, and 4109 Computer Display Terminals with Standalone Power Specialized for Graphics Tasks

It offers all the elements necessary to locally write, edit, compile, link, debug, and run programs; to control 4105, 4107, or 4109 terminals; and to control peripherals connected to the system.

The 4170 consists of a standalone microprocessor, local mass storage and local memory on an industry standard CP/M-86 operating system, FORTRAN-86 compiler, four serial I/O ports, and Tektronix graphics software support.

Dual Microprocessors Speed Local Processing

The 4170 is powered by the 16-bit Intel 8086 and the 8087 Numeric Co-processor which speeds floating point operations. The chips provide powerful throughput and 20-bit addressability.

The 4170 comes standard with 256 kbytes of error checking and correcting memory. The 4170's total capacity is 896 kbytes. This provides host independence and more programming workspace in error free local memory.

The 4170 has two 5¼ inch disk drives as standard, allowing work to be easily backed up, system programs and user files maintained separately, and programs changed when necessary. Each formatted diskette can hold 327 kbytes of data. Ten Mbytes of Winchester hard disk storage is optionally available for larger mass storage requirements.

The 4170 allows the user to locally perform pre- and post-processing of graphics information, calling upon the host only when intensive processing is needed. The result is greater host efficiency; the ability to support more terminals and; most importantly, greater individual user productivity in a time sharing environment.

Self-diagnostics make system adjustments quick to identify and repairs readily verified.

CHARACTERISTICS

PROCESSORS

Intel 8086 MPU.

Intel 8087 Numeric Co-Processor.

MEMORY

Port A 375 ns ≤ memory cycle of Port B <1.2 μs.

Standard — 256 k Error Checking and Correcting.

Option 30 — 512 k Error Checking and Correcting.

Option 31 — 768 k Error Checking and Correcting.

Option 32 — 896 k Error Checking and Correcting.

DISK STORAGE

Standard — Two each 5¼ in Floppy Disk Drives, 327 k formatted capacity per diskette, IBM P.C. compatible, 125 kbits/s transfer rate.

Option 03 — 5¼ in Winchester Disk Drive, 10 Mbytes formatted capacity, 5 Mbits/s transfer rate.

COMMUNICATIONS INTERFACE

Standard — Host Port RS-232C DTE, Terminal Port RS-232C DCE, two Peripheral Ports RS-232C DCE.

Option 10 — Three additional RS-232 Ports, all RS-232 Ports are capable of 300, 600, 1200, 2400, 4800, 9600, 19.2 kbaud.

COLOR COPIER INTERFACE

Option 09 — 4690 Series Color Copier Interface.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	224	8.8
Height	597	23.5
Depth	622	24.5
Depth (with cables)	673	26.5
Weight	**kg**	**lb**
Net	22.2	49.0

INCLUDED ACCESSORIES

Cue card (334-0083-00); pkg of 10 blank diskettes (119-1583-00); one set system software diskettes (016-0764-00); 12 ft host port RS-232 cable (012-0911-00); self-test adaptor (067-1043-00); instruction manual.

ORDERING INFORMATION

4170 Local Graphics Processing Unit . **$5,500**

Option 03*1 — Hard Disk ..... **+$3,000**
Option 09*1 — Parallel Interface (for Copiers and Plotters) ..... **+$500**
Option 10*1 — Additional Three-Port Peripheral Interface ..... **+$950**
Option 30*1 — Additional 256 K RAM ..... **+$1,790**
Option 31*1 — Additional 512 K RAM ..... **+$3,580**
Option 32*1 — Additional 640 K RAM ..... **+$4,480**
Option 44 — Disk Interface Flexible Disk ..... **NC**
Option 45*1 — Disk Interface Hard and/or Flexible Disk ..... **+$1,100**

**1 Also available as a Field Upgrade.*

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY PLUS* SERVICE PLAN** REFER TO PAGE 41

N1 — Service Plan + 9 Months Service ..... **+$340**

OPTIONAL ACCESSORIES

Alignment Diskette Order 119-1692-00 ..... **$65**
Extender Board Order 067-1005-00 ..... **$300**

OEM terms available on this product.

NEW

COLOR GRAPHICS COPIER

4695 Color Graphics Copier

Unprecedented Image Quality in its Price Range

Clear Transparency Capability

Quiet, 20 Character/Second Printing

Small, Compact Package

Choice of Roll or Sheet Paper

The 4695 Color Graphics Copier Provides Low Cost, High Performance Color Copying from the 4105/4107/4109 Computer Display Terminals and Other Raster Data Sources

The 4695's unique implementation of drop-on-demand ink-jet technology provides addressability of 4.8 dots per mm (120 dots per inch) in both horizontal and vertical directions. This allows up to 1280 x 960 points per A size (8½ x 11 in) image.

A Multipurpose Output Device

In addition to providing high quality color graphics copies, the 4695 can function as a bi-directional, dot matrix printer with a print speed of 20 characters per second. A specially formulated clear transparency media can be used with the 4695 to develop striking, full color presentations. Paper is fed automatically from a roll or precut sheets are fed manually.

Companion Copier for the 4100 Color Terminal Family

The 4695 is plug-compatible with the 4105, 4107, and 4109 Computer Display Terminals. Copiers are generated either by program command, or by pushing a button on the terminal keyboard. Copies from the 4105 are 8 x 6 in (vertically oriented) while copies from the 4107 and 4109 are 10.7 x 8 in (horizontally oriented).

As a special feature, the 4695 can copy from the terminal graphics area while the dialog area continues to communicate with the host. The 4695 also copies up to 125 half-toned shades from the 4100 Family display.

A Copier for Other Data Soures

The 4695's interface is modeled after the Centronics-style parallel interface, with modifications to support color. Detailed interface specifications and functional descriptions of driving routines are available from Tektronix.

CHARACTERISTICS

Addressability — Horizontal and Vertical: 4.8 dots/mm (120 dots/in).

Copy Time — 4105: 2 to 3.5 min. 4107/4109: 3 to 5.25 min.

Printing Speed — 20 characters/s.

Character Set — Full ASCII including control characters.

Printing Matrix — 12 x 16 dot matrix.

Page and Image Format — A (8½ x 11 in) and A4 (297 x 210 mm). Landscape/Portrait format selectable under program control.

Image Size — 4105 Copy: 8 x 6 in portrait format. 4107, 4109 Copy: 10.6 x 8 in landscape format.

Colors — Eight (magenta, yellow, cyan, red, green, blue, black, white).

Media Types — Paper sheet, paper roll, overhead transparency.

Interface — Eight bit parallel.

AC POWER

Line Voltage — 47 Hz to 63 Hz, 99 V ac to 132 V ac, 198 V ac to 264 V ac.

Input Power — 120 W or less.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	500	19.7
Height	151	5.9
Depth	336	13.2
Weight	**kg**	**lb**
Net	11.0	24.2

INCLUDED ACCESSORIES

One roll ink jet copy paper (016-0743-00); two each yellow (016-0734-00); magenta (016-0735-00); cyan (016-0736-00); black (016-0737-00); interconnecting cable (012-0555-00); power cable (161-0066-00); operator's manual.

ORDERING INFORMATION

4695 Color Graphics Copier **$1,595**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$430**

OPTIONAL ACCESSORIES

Service Manual

Ink Jet Paper, (6 rolls/pkg) — Order 016-0743-00 ..... **$50**

Ink Jet Paper, (500 sheets/pkg)
"A" Size: 8.5 in x 11.0 in (216 x 279 mm)
Order 016-0739-00 ..... **$25**

"A4" Size: 297 mm x 210 mm) — Order 016-0740-00 .. **$22**

Transparency Film*[1]

Ink Jet Cartridges (2.5 cc ea, 16/pkg)

Yellow — Order 016-0734-00 ..... **$25**

Magenta — Order 016-0735-00 ..... **$25**

Cyan — Order 016-0736-00 ..... **$25**

Black — Order 016-0737-00 ..... **$25**

Maintenance Liquid Order 016-0732-00 ..... **$10**

Protect Liquid (Shipping Fluid) —
Order 016-0733-00 ..... **$4.00**

Lubricant (5 cc) — Order 016-0742-00 ..... **$1.65**

[1] Available Winter 1983

See this color product in the reference section beginning on page 9.

OEM terms available on this product.

NEW

4691 Color Graphics Copier

High Image Quality and Excellent Color Saturation

Adjustable for A and B Size

Landscape and Portrait Formats

Clear Transparency Capability

Four-Way Multiplexer Option

125 Color Shades from Local Programmability and PLOT 10 Easy Graphing II

The 4691 Color Graphics Copier Provides High Performance Color Copying from the 4113B/4113B30, 4115B/M4115B Computer Display Terminals and Other Raster Data Sources

Copies are easily made in A size (8.5 x 11 in) or B size (11 x 17 in) and their metric equivalents, in approximately two to three and a half minutes. The high performance drop-on-demand ink-jet technology provides addressability of six dots per mm (150 dots per inch) in both horizontal and vertical directions. This allows up to 1560 x 2460 points in a B size image, and up to 1560 x 1200 points in an A size image. True black is obtained by using a separate black ink supply, superior to that obtained from mixed pigments. With the optional transparency adaptor kits (Opt 03/04), vivid overhead transparencies can be produced.

Copies are generated by program command, or by pushing a button on the Tektronix 4113B or 4115B terminal keyboard. Image orientation and multiple copies of the same image can be requested under program control.

Flexible Configuration

The 4691 uses a Centronics-type parallel interface, with modifications from the basic standard to support color, four-channel multiplexing and faster data transfer. With four-channel multiplexing (Option 02), the 4691 can serve up to four data sources at once.

With Option 09, the 4691 is compatible with the Tektronix 4113B and 4115B Computer Display Terminals. And as a special feature, the 4691 copies 125 callable shades under PLOT 10 Easy Graphing II and Local Programmability.

When supported by a host driving routine and rasterizing software, the 4691 is compatible with many systems offering a Centronics-style parallel output port.

CHARACTERISTICS

Addressability — Vertical and Horizontal: 6 dots/mm (150 dots/in).

Copy Time — 2.0 to 3.5 min depending on format.

Page and Image Format — B and A, or A3 and A4 Output Sizes. Landscape and Portrait Format selectable under program control.

Image Sizes — Variable depending on page size and image source.

Colors — Eight (magenta, yellow, cyan, red, green, blue, black, white).

Media Types — Paper sheet, overhead transparency.

Compatibility — 4113B/4113B30 Option 09 and 4115B/M4115B Option 09. Order 4110F09 and level three firmware to upgrade an existing 4113 for compatibility.

Interface — Eight bit parallel.

Data Rate — Up to 400 kbytes/s (burst mode).

AC POWER

Line Voltage — 90 V ac to 110 V ac, 105 V ac to 129 V ac, 180 V ac to 220 V ac, or 211 V ac to 258 V ac, all at 48 Hz to 62 Hz.

Input Power — 500 W operating.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	608	23.9
Height	346	13.6
Depth	821	32.3
Weight	**kg**	**lb**
Net	60.0	132.0

INCLUDED ACCESSORIES

500 sheets (B size and A3 size when Opt 01 is ordered) ink jet copy paper (016-0711-00); 200 ml capacity each ink jet cartridges, cyan (016-0713-00); black (016-0714-00); yellow (016-0715-00); magenta (016-0716-00); 10 ft interconnecting cable 3 meters (012-0518-00); power cable (161-0104-00); "A" and "B" Size (Standard) paper tray (118-2557-00); "A3" and "A4" Size (if Option 01 is ordered) paper tray (118-2556-00); 3/pkg drum adaptors (118-2593-00); operator's manual, operator's guide.

ORDERING INFORMATION

4691 Color Graphics Copier **$12,950**

Option 01 — Setup for A3 Size Output ..... **NC**

Option 02 — Four Channel Multiplexer.*1

Option 03 — Transparency Adaptor Kit, A size ..... **NC**

Option 04 — Transparency Adaptor Kit, A4 size ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan +9 Months Service ..... **+$900**

*1 *Price available upon request.*

OPTIONAL ACCESSORIES

Service Manual

Device Driver Development Guide

Test Fixture — Order 067-1158-00 ..... **$250**

Interconnect Cable — Nine meter (29.9 ft).
Order 012-0527-00 ..... **$150**

Ink Jet Copy Paper — "A" Size, 216 x 279 mm (8.5 in x 11 in) (500 sheets/pkg).
Order 016-0712-00 ..... **$25**

"B" Size — 279 x 432 mm (11 in x 17 in).
Order 016-0711-00 ..... **$40**

"A4" Size — 297 x 210 mm (For use w/Opt 01 only).
Order 016-0709-00 ..... **$20**

"A3" Size — 297 x 420 mm (For use w/Opt 01 only).
Order 016-0710-00 ..... **$35**

Transparency Film — "A" Size 100 sheets/pkg.
Order 016-0765-00 ..... **$85**

Transparency Kit — "A" Size (Field Retrofit).
Order 020-1161-00 ..... **$200**

"A4" Size — Order 020-1162-00 ..... **$200**

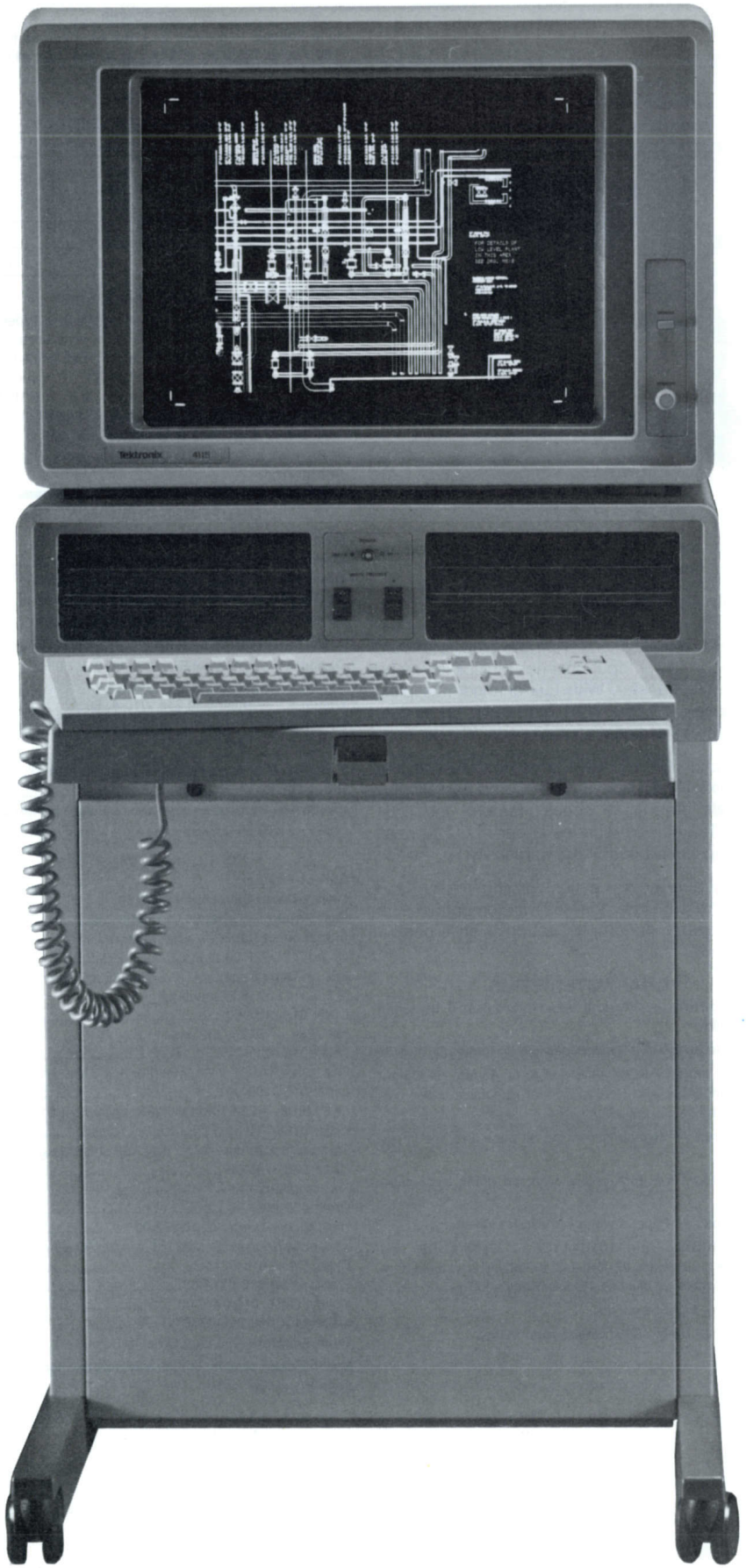
Ink Jet Cartridges — (200 cc) See Included Accessories
Cyan: Order 016-0713-00 ..... **$85**
Black: Order 016-0714-00 ..... **$85**
Yellow: Order 016-0715-00 ..... **$85**
Magenta: Order 016-0716-00 ..... **$85**

Drum Adaptors — 3/pkg. Order 118-2593-00 ..... **$15**

See this color product in the reference section beginning on page 9.

NEW

COLOR DISPLAY TERMINALS



4115B/M4115B

Computer Display Terminal

High Performance Color With Unparalleled Resolution and Speed

Up to 256 Colors Displayed from a Palette of 16 Million Colors.

Autoconvergence

Up to Eight Work Surfaces

Local True Zoom and Pan

Compatibility with 4010, 4100, and 4110 Series Hardware and Software

The Tektronix 4115B is a High Resolution Computer Display Terminal that Combines High Performance Graphics with Unmatched Display Quality

The display controller redraws a high density mechanical drawing or typical gate array design in less than a second. With its 32-bit coordinate space and 256 simultaneously displayable colors, the 4115B extends the leading edge of graphics display. The 4115B also offers all the powerful local graphics functions of the Tektronix 4110 Series—including local picture segments and true zoom and pan.

Unsurpassed Display Resolution

The 4115B's 483 mm (19 in) raster scan display achieves unparalleled line quality with resolution of 1280 x 1024 pixels. The resolution is further refined by a precise contrast ratio, by low reflection maintained via a multilayer filter, and by automatic control of display convergence. A 60 Hz noninterlaced refresh rate also improves display clarity and productivity by greatly reducing flicker and resultant eye fatigue.

An 8086 CPU and 8087 Coprocessor Teams up with a Bipolar Bit Slice Graphics Processor to Yield Singularly Fast Response Times

50,000 vectors can be drawn in less than a second. Panel fill occurs at a rate of 10,000 rectangles per second. Large rectangular areas may be color filled at a rate of 125 million pixels per second.

4110 Series/PLOT 10 Compatible

The 4115B is fully supported by the Tektronix PLOT 10 IGL (Interactive Graphics Library) and is designed for ease of integration with other 4110 Series terminals and with software available from other sources.

The 4115B Option 09 provides plug-compatibility with the Tektronix 4691 Color Graphics Copier. 150 dots per inch resolution is attained with this high performance, ink-jet device.

The 4115B can be configured either as a pedestal unit with detached low profile keyboard or in separate display, processing, and keyboard modules (M4115B) for flexibility in configuring workstations. Local memory can be expanded to 800 kbytes of RAM. Mass storage is available in combinations of single or dual flexible and Winchester disk drives.

CHARACTERISTICS

DATA TRANSMISSION

Data Rate — 19.2 kbaud.

Communications Interface — RS-232C.

MEMORY

Standard — 288 kbytes, expandable to 800 kbytes.

DISPLAY

Medium — Color raster.

Size — 483 mm (19 in) diagonal.

Refresh Rate — 60 Hz, noninterlaced.

Convergence — Automatic

KEYBOARD

Normal Keyboard — 72 typewriter paired upper and lower case, programmable and autorepeating.

User Definable Programmable Function Keys — Eight.

Terminal Control Keys — Four.

Zoom and Pan Keys — Four.

Graphic Cursor Control — Thumbwheels.

GRAPHICS MODE

Addressability — Four billion x four billion.

Resolution — 1280 x 1024 pixels.

Graphic Command Syntax — PLOT 10 compatible, 4010, 4100 and 4110 Series compatible.

Colors — 16 standard, expandable to 256.

Palette Selection — 16 million.

ALPHANUMERIC MODE

Character Set — 94 (full ASCII).

Character Format — 80 columns, 34 rows and 160 columns, 64 rows.

AC POWER

Line Voltage — 115 V, 230 V RMS.

Line Frequency — 48 Hz to 66 Hz.

Power — 1400 W.

PHYSICAL CHARACTERISTICS

Dimensions	Module		Pedestal	
	mm	in	mm	in
Width	406	16.0	610	24.0
Height	622	24.5	876	34.5
Depth	762	30.0	787	31.0
Weight	**kg**	**lb**	**kg**	**lb**
Net	65.0	140.0	75.0	165.0

PHYSICAL CHARACTERISTICS

Dimensions	Display		Keyboard	
	mm	in	mm	in
Width	584	23.0	508	20.0
Height	406	16.0	43	1.7
Depth	559	22.0	203	8.0
Weight	**kg**	**lb**	**kg**	**lb**
Net	55.0	120.0	2.5	5.0

INCLUDED ACCESSORIES

Two 8 ft power cables (161-0123-00); 12 ft host port RS-232 cable (012-0911-00); 3 4115B BNC cables (012-0074-00); 4115B display assembly to pedestal cable (012-0525-00); pkg of 6 function key overlays (334-3290-02); 3 BNC cables, (M4115B only) (175-2753-00); 10 ft display assembly to pedestal cable (012-0387-00); operator's manual; 4110 series host programmer's manual; 4110 series command reference manual; 4110 series command reference guide; introduction brochure.

ORDERING INFORMATION

4115B Computer Display Terminal ... **$19,950**

M4115B Computer Display Terminal Workstation **$19,950**

Option 01 — Extended Communications Interface .... **+$950**

Option 2A — Additional 256 Kbytes RAM with ECC **+$2,300**

Option 2B — Additional 512 Kbytes RAM with ECC . **+$4,600**

Option 3A — DMA Interface for DEC VAX Unibus; Requires Option 3B or Modified Cable ..... **+$4,500**

Option 3B — 30 ft Cable for Option 3A; Must be Ordered Separately ..... **+$250**

Option 4A — United Kingdom Keyboard ..... **+$120**

Option 4C — Swedish Keyboard ..... **+$120**

Option 4F — Danish/Norwegian Keyboard ..... **+$120**

Option 4K — Japanese (Katakana) Keyboard ..... **+$120**

Option 09 — 4690 Series Color Copier Interface ..... **+$500**

Option 10 — Three-port Peripheral Interface ..... **+$1,200**

Option 13 — Graphic Tablet, 11 x 11 in, with Controller ..... **+$2,950**

Option 14 — Graphic Tablet, 30 x 40 in, with Controller ..... **+$4,950**

Option 22 — Additional Two Planes Display Memory ..... **+$3,000**

Option 23 — Additional Four Planes Display Memory ..... **+$6,000**

Option 42 — Single Flexible Disk with Controller .... **+$1,700**

Option 43 — Dual Flexible Disk with Controller ..... **+$2,600**

Option 45 — Mass Storage Interface ..... **+$1,500**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$1,025**

OPTIONAL ACCESSORIES

DMA I/F Manual

Service Manual Vol I

Service Manual Vol II

Display Service Manual

Loop Connector for Host-Port Test (RS-232) — Order 067-1043-00 ..... **$17**

Current Loopback Connector — Order 067-1042-00 .... **$13**

411X Logic Extender Board — Order 067-1005-00 ..... **$300**

Raster Bus Extender Board — Order 067-1173-00 ..... **$125**

Media, Flexible Disk (pkg of 10) — Order 119-1376-01 . **$110**

Calibration Graticule, Display — Order 067-1142-00 .. **$235**

Convergence Checker RCA Type 507R — Order 067-1164-00 ..... **$470**

All standard and optional accessories for the M4115B are the same as those for the 4115B except for the following:

OPTIONAL ACCESSORIES

Display Stand, (Tilts, Swivels, Stands on Floor) — Order 016-0717-01 ..... **$750**

Ergonomic Chair — Order 016-0698-00 ..... **$600**

COMPANION PRODUCTS

4691 Color Graphics Copier **$12,950**

4634 Hard Copy Unit **$7,900**

4662 Digital Plotters **$2,995**

4663 Digital Plotters **$9,990**

4926 10 MB Hard Disk **$4,200**

See this color product in the reference section beginning on page 9.

NEW

COMPUTER DISPLAY TERMINAL

4112B Computer Display Terminal

Raster Scan Display with Local Picture Segments

2-D Transforms, True Zoom and Pan up to Three Memory Planes

Compatible with Tektronix 4010, 4100 and 4110 Series Terminals

The 4112B Computer Display Terminal was Designed to Satisfy a Broad Range of Evolving Graphic Needs, from Basic Line Graphs to High Density Design

It provides access to an unusually wide assortment of graphics capabilities, and its powerful local intelligence keeps user interactivity high ... host dependency low. The upgraded "B" Series provides for our new ANSI X3.64 and Winchester disk capability. Earlier 4112 terminals can easily be field upgraded to 4112B.

The 4112B offers a bright, flicker-free 15-inch (diagonal) raster scan display. Eight user definable programmable function keys are provided.

The 4112B is compatible with the popular Tektronix 4010, 4100 and 4110 Series of Computer Display Terminals

Programs developed for the 4012 or 4014, for example, may require only minor software revisions to run on the 4112B. Updating existing programs for 4112B features is a simple process using the modular device drivers and advanced feature support of the Tektronix PLOT 10 Interactive Graphics Library (IGL).

Local Picture Segments

A local picture segment is a group of graphic primitives that describes a portion of a picture. These primitives are retained in the terminal's memory to be redrawn and manipulated at any time. Schematic components, symbols, titles and text can be defined as segments, for example, then stored in local memory and redrawn when needed, with minimal computer time and communications traffic required. Local segments may also be rotated, scaled or moved around the screen, by a simple command from the host processor (2-D Transforms).

Zoom and Pan

An addressable display space of 4096 x 4096 points is accessible locally by simple, key-actuated zoom and pan or via the host. The thumbwheel controls are used to pan the display with a rectangular cursor and to set the viewport dimensions of the magnified image.

Multiple Display Memory Planes

Two additional memory planes may be added to the 4112B, via Option 20, to provide as many as three display surfaces. This optional capability enables a number of effects, including overlays of text and/or graphic information plus gray scale.

Definable Dialog Area

At any time, the user can specify the size and position of the region where communications between terminal and host are displayed. This dialog area is scrollable by the thumbwheels, allowing for easy recall of previous communications.

CHARACTERISTICS

DATA TRANSMISSION

Data Rate — 9600 baud.

Block Mode — Option 01.

Communications Interface — EIA RS-232C, compatible, full or half duplex.

DISPLAY

Medium — Raster scan CRT.

Dimensions — 220 mm x 254 mm (8.6 in x 11.5 in) 381 mm (19 in) diagonal.

Scan Type — 50 Hz or 60 Hz, noninterlaced.

Phosphor — White WW (P4).

MEMORY

Standard Display Memory — 72 kbytes.

Standard Graphics Memory — 288 kbytes (expandable to 672 kbytes).

KEYBOARD

Normal Keyboard — 72 typewriter paired, upper and lower case, programmable and autorepeating (seven lighted).

User-Definable Programmable Function Keys — Eight, four terminal control, four special function.

ALPHANUMERIC MODE

Character Set — 94 (full ASCII) or 128 in snoopy mode.

Character Format — 80 columns, 34 rows, 7 x 9 dot matrix.

GRAPHICS MODE

Resolution — 640 horizontal x 480 vertical pixels.

Addressability — 4096 x 4096 points.

Command Syntax — PLOT 10 compatible.

Line Types — Solid, dashed, erase.

Graphic Primitives — Vectors, polygons, text.

AC POWER

90 V ac to 132 V ac, 6.25A max, 48 Hz to 62 Hz or 180 V ac to 250 V ac, 3A max, 48 Hz to 62 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	404	15.9
Height	546	21.5
Depth	825	48.0
Weight	**kg**	**lb**
Net	46.3	102.0

INCLUDED ACCESSORIES

8 ft power cord (161-0123-00); 12 ft host-port RS-232 cable (012-0911-00); pkg of 8 re-legendable key caps (366-1882-00); pkg of 6 function key overlays (334-3290-01); operator's manual; host programmer's manual; 4110 series command reference manual; introduction brochure; firmware instructions version 5.1/1.3 manual.

ORDERING INFORMATION

4112B Computer Display Terminal **$6,500**

Option 01 — Extended Communications ..... +$950
Option 4A — United Kingdom Keyboard ..... +$120
Option 4C — Swedish Keyboard ..... +$120
Option 4F — Danish/Norwegion Keyboard ..... +$120
Option 4K — Japanese (Katakana) Keyboard ..... +$120
Option 10 — Three-Port Peripheral Interface ..... +$1,200
Option 11 — External Video Output ..... +$500
Option 13 — 11 x 11 in Graphic Tablet with pen .... +$2,950
Option 14 — 30 x 40 in Graphic Tablet with pen .... +$4,950
Option 20 — (2) Display Memory Planes ..... +$2,600
Option 28 — Additional 256 Kbytes of RAM ..... +$2,300
Option 29 — Additional 512 Kbytes of RAM ..... +$4,600
Option 42 — Single Flexible Disk ..... +$1,700
Option 45 — Mass Storage Interface ..... +$1,500

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz

***WARRANTY-PLUS* SERVICE PLAN** REFER TO PAGE 41

N1 — Service Plan + 9 Months Service ..... +$340

Optional Accessories

Service Manuals
Cal Fixture Loopback Connector for Host-Port Test (RS-232) — Order 067-1043-00 ..... **$17**
Cal Fixture, Current Loop Back Connector — Order 067-1042-00 ..... **$13**
Cal Fixture, Extender Board — Order 067-1005-00 .... **$300**
Cal Fixture, Extender Cable Order 067-1053-00 ..... **$140**
Media, Flexible Disk (pkg of 10) — Order 119-1376-01 ..... **$110**

OEM terms available on this product.

NEW

COLOR DISPLAY TERMINALS

4113B/4113B30
Computer Display Terminal

Raster Scan Color Display

Local Picture Segments

2-D Transforms, True Zoom and Pan

Compatible with Tektronix 4010, 4100 and 4110 Series Terminals

The 4113B Computer Display Terminal Continues the Evolution of the 4110 Series of Intelligent Display Terminals
It supports additional color raster features while maintaining compatibility with the 4112B and the 4114B. The upgraded "B" Series provides for our new ANSI X3.64 and Winchester disk capability. Earlier 4113 terminals can easily be field upgraded to 4113B.

The 4113B features true zoom and pan, and multiple viewports. In addition, three memory planes display any eight colors at one time (or 16 colors via Option 21).

Local Picture Segments
A local picture segment is a group of graphic primitives that describe a portion of a picture. Schematic components, symbols, titles, and text can be defined as segments, then stored in local memory and redrawn in a specified color as needed, with minimal host time. Local segments may also be scaled, rotated, or moved around the screen, by a single command from the host (2-D Transforms).

Zoom and Pan
An addressable 4096 x 4096 display space is accessible by key-actuated zoom and pan or via the host. Thumbwheel controls pan the display with a rectangular cursor and set dimensions of the magnified image.

Multiple Display Memory Planes
Besides being used to specify colors, the memory (bit) planes provide for overlaying text and/or graphic information, useful in the preparation of multi-layer pictures.

4113B30 Workstation

Computer display terminal operators can improve their performance with the efficiency, convenience, and comfort of the 4113B30 modular workstation.

The pedestal module contains the power supply, circuit board cage and also houses one or two optional flexible disk drives for convenient local storage. Supporting the display at eye level, the optional table module can be installed on the left or the right side of the pedestal. The keyboard for the 4113B30 can be detached from the table module for positioning in the lap, on the pedestal, or underneath the display screen.

CHARACTERISTICS

DATA TRANSMISSION
Data Rate — 9600 baud.
Block Mode — Option 01.
Communications Interface — RS-232C.

DISPLAY
Medium — Shadow-mask color raster tube.
Size — 483 mm (19 in) diagonal.
Refresh Rate — 50 Hz or 60 Hz, noninterlaced.

MEMORY
Standard — 88 kbytes ROM, 288 kbytes RAM expandable to 800 k.

KEYBOARD
Normal Keyboard — 72 typewriter paired upper and lower case, programmable, auto repeating (seven lighted).
User Definable Programmable Function Keys — Eight.
Terminal Control Keys — Four.
Zoom and Pan Keys — Four.
Graphic Cursor Control — Thumbwheels.

GRAPHICS MODE
Addressability — 4096 x 4096 points.
Resolution — 640 x 480 pixels.
Line Types — Solid, dashed.
Graphic Command Syntax — PLOT 10 compatible.
Graphics Primitives — Vectors, panels, text.
Colors (Three-Bit Plane) — Eight.
Colors (Four-Bit Plane) — 16.
Palette Selection — 4096.

ALPHANUMERIC MODE
Character Set — 94 (full ASCII).
Character Format — 80 columns, 34 rows, 7 x 9 matrix in 8 x 14 (pixel) area.

AC POWER
90 V ac to 132 V ac, 10 A max or 198 V ac to 250 V ac, 5 A max; 50 Hz or 60 Hz.

PHYSICAL CHARACTERISTICS (4113B)

Dimensions	mm	in
Width	584	23.0
Height	1350	53.0
Depth	787	31.0
Weight	**kg**	**lb**
Net	125 .0	275.0

PHYSICAL CHARACTERISTICS (4113B30)
Monitor Height — 425 mm (16.75 in).
Width — 584 mm (23 in).
Depth — 582 mm (22.9 in).
Pedestal Height — 743 mm to 762 mm (29 in to 30 in).
Width — 565 mm (22.25 in).
Depth — 851 mm (33.5 in).
Keyboard Height — 38 mm to 70 mm (1.5 in to 2.75 in).
Width — 508 mm (20 in).
Depth — 229 mm (9 in).
Table Height — 673 mm to 692 mm (26.5 in to 27.2 in).
Width — 1219 mm (48 in).
Depth — 762 mm (30 in).
Total Weight — 166.1 kg (296.5 lb).

INCLUDED ACCESSORIES 4113B/4113B30
8 ft power cord (161-0123-00); 12 ft host-port RS-232 cable (012-0911-00); 4113B pedestal to display power cable (161-0145-00); 3 4113B BNC cables (012-0074-00); pkg of 8 re-legendable key caps (366-1882-00); pkg of 6 function key overlays (334-3290-01); operator's manual; host programmer's manual; 4110B series command reference manual; instruction brochure.

INCLUDED ACCESSORIES 4113B30
Display swivel/tilt base (016-0467-01); pedestal to display power cable (161-0126-00); display power control cable (012-1021-00); 3 10 ft BNC cables (175-2753-00); 4110B30 series desk configuration service manual.

ORDERING INFORMATION

4113B Computer Display Terminal ... **$16,500**

4113B30 Computer Display Terminal Workstation **$18,000**

Option 01 — Extended Communications ..... **+$950**
Option 4A — United Kingdom Keyboard ..... **+$120**
Option 4C — Swedish Keyboard ..... **+$120**
Option 4F — Danish/Norwegian Keyboard ..... **+$120**
Option 4K — Japanese (Katakana) Keyboard ..... **+$120**
Option 09 — Color Hard Copy I/F ..... **+$500**
Option 10 — Three-Port Peripheral Interface ..... **+$1,200**
Option 12 — External Video Output ..... **+$1,150**
Option 13 — 11 x 11 Inch Graphic Tablet w/Pen .... **+$2,950**
Option 14 — 30 x 40 Inch Graphic Tablet w/Pen .... **+$4,950**
Option 21 — Display Memory Plane ..... **+$1,500**
Option 28 — Adds 256 Kbytes of RAM ..... **+$2,300**
Option 29 — Adds 512 Kbytes of RAM ..... **+$4,600**
Option 32 — Table Module (4113B30 only) ..... **+$500**
Option 42 — Single Flexible Disk and Disk Controller ..... **+$1,700**
Option 43 — Dual Flexible Disk and Disk Controller . **+$2,600**
Option 45 — Mass Storage Interface ..... **+$1,500**

INTERNATIONAL POWER CORD AND PLUG OPTIONS
Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN** **REFER TO PAGE 41**
N1 — Service Plan + 9 Months Service ..... **+$810**

4691 Color Graphics Copier **$12,950**

Tektronix offers service training classes on the 4113B and 4113B30. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.

See this color product in the reference section beginning on page 9.

OEM terms available on this product.

NEW

COMPUTER DISPLAY TERMINALS

4114B/4114B30
Computer Display Terminal

Direct View Storage Tube with Local Picture Segments

2-D Transforms, Refresh Support and Fast Redraw

Compatible with Tektronix 4010, 4100 and 4110 Series Terminals

The 4114B Computer Display Terminal Satisfies the Needs of Graphics Users for Faster, More Versatile Throughput in High Density Graphics Applications.
Its local intelligence and expandable memory can significantly reduce the delays and costs associated with over-dependence on a host computer. The 4114B has a resolution high enough for the most complex engineering and scientific graphics. The upgraded "B" Series provides for our new Local Programmability capability. Earlier 4114 or 4114A terminals can easily be field upgraded to 4114B.

Direct local access to all 4114B features under program control is provided by the addition of either the 4100P01 or 4100P02 local programmability products.

The 4114B is Compatible with Tektronix 4010, 4100 and 4110 Series Computer Display Terminals.
Using the modular device drivers and advanced feature support of Tektronix PLOT 10 IGL (Interactive Graphics Library) makes updating existing programs a simple process.
The 4114B supports local picture segments which are a group of graphic primitives describing a portion of a picture, retained as a unit in local memory to be redrawn or manipulated at any time. Schematic components, symbols, titles, and text can be defined as segments, then stored and recalled easily. Local segments can be rotated, scaled or moved around the screen, with only a simple command from the host or a local program.

Refresh Support
Local generation of more than 1500 cm or approximately 3000 short vectors of flicker-free refresh. Option 31 provides color enhanced (amber) refresh for easy recognition of refresh information.

4114B30 Workstation

Computer display terminal operators can improve their performance with the efficiency, convenience and comfort of the 4114B30, modular workstation.

The pedestal module contains the power supply and circuit board cage, and also houses one or two optional flexible disk drives for convenient local storage. Supporting the display at eye level, the table module can be installed on the left or the right side of the pedestal. The keyboard for the 4114B30 can be detached from the table module for positioning in the lap, on the pedestal, or underneath the display screen.

CHARACTERISTICS

DATA TRANSMISSION

Data Rate — 50 b/s to 19,200 b/s.

Data Type — 7-bit asynchronous serial ASCII, plus parity bit.

Block Mode — Option 01 Extended Communications.

Communications Interface — RS-232C.

DISPLAY

Medium — Direct view storage tube; 4096 x 4096 addressable points; 4096 x 3120 displayable points; enhanced refresh; fast redraw.

Dimensions — 368 mm x 277 mm (14.5 in x 10.9 in); 483 mm (19 in) diagonal.

MEMORY

Standard — 56 kbytes ROM and 288 kbytes RAM (expandable to 800 k).

KEYBOARD

Normal Keyboard — 72 typewriter paired, upper and lower case, programmable and auto repeating, (five lighted). User Definable Programmable Function.

User Definable Programmable Function Keys — Eight.

Graphic Cursor Control — Thumbwheels.

Alpha Cursor Position — Key control.

Scrolling — Thumbwheels.

GRAPHICS MODE

Addressability — 4096 x 4096.

Line Types — Solid dashed, defocused.

Drawing Speed (Storage) — 134 m/s.

Drawing Speed (Refresh) — 537 m/s.

Graphic Command Syntax — Tektronix PLOT 10 compatible.

ALPHANUMERIC MODE

Standard Displayable Character Set — 94 characters (full ASCII).

AC POWER

90 V ac to 132 V ac, 11 A max or 180 V ac to 250 V ac, 5.5 A max, 48 Hz to 62 Hz.

PHYSICAL CHARACTERISTICS (4114B)

Dimensions	mm	in
Width	597	23.5
Height	1290	51.0
Depth	813	32.0
Weight	**kg**	**lb**
Net	107.5	237.0

PHYSICAL CHARACTERISTICS (4114B30)

Monitor Height — 425 mm (16.8 in).
Width: 584 mm (23.0 in).
Depth: 582 mm (22.9 in).

Pedestal Height — 743 mm to 762 mm (29 in to 30 in).
Width: 565 mm (22.3 in).
Depth: 851 mm (33.5 in).

Keyboard Height — 38 mm to 70 mm (1.5 in to 2.8 in).
Width: 508 mm (20.0 in).
Depth: 229 mm (9.0 in).

Table Height — 673 mm to 692 mm (26.5 in to 27.2 in).
Width: 1219 mm (48.0 in).
Depth: 762 mm (30.0 in).

Total Weight — 165.9 kg (365.7 lb).

INCLUDED ACCESSORIES 4114B/4114B30

8 ft power cord (161-0123-00); 21 in pedestal to display power cable (161-0145-00); 12 ft host port RS-232 cable (012-0911-00); pkg of 8 re-legendable key caps (366-1882-00); pkg of 6 function key overlays (334-3290-01); 4114B/4116B operator's manual; 4114B/4116B host programmer's manual; 4110B Series command reference; 4114B/4116B introduction brochure.

All accessories for the 4114B30 are the same as those for the 4114B, except for the following:

Display swivel/tilt base (016-0467-01); pedestal to display power cable (161-0126-00); 4110B30 series desk configuration service manual.

ORDERING INFORMATION

4114B Computer Display Terminal ... **$17,900**
4114B30 Computer Display Terminal Workstation **$19,400**

Option 01 — Extended Communications ..... **+$950**
Option 4A — United Kingdom Keyboard ..... **+$120**
Option 4C — Swedish Keyboard ..... **+$120**
Option 4E — APL Keyboard ..... **+$750**
Option 4F — Danish/Norwegian Keyboard ..... **+$120**
Option 4K — Japanese (Katakana) Keyboard ..... **+$120**
Option 10 — Three - Port Peripheral Interface ..... **+$1,200**
Option 13 — 11 x 11 in Graphic Tablet w/Pen ..... **+$2,950**
Option 14 — 30 x 40 in Graphic Tablet w/Pen ..... **+$4,950**
Option 28 — Adds 256 Kbytes of RAM ..... **+$2,300**
Option 29 — Adds 512 Kbytes of RAM ..... **+$4,600**
Option 31 — Color Enhanced Refresh ..... **+$1,000**
Option 32 — Table Module (4114B30 only) ..... **+$500**
Option 41 — Ten-Slot Peripheral Bus Extender; 90-110 line voltage ..... **+$350**
Option 42 — Single Flexible Disk and Disk Controller ..... **+$1,700**
Option 43 — Dual Flexible Disk and Disk Controller . **+$2,600**
Option 45 — Mass Storage Interface ..... **+$1,500**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$810**

OPTIONAL ACCESSORIES

Ergonomic Chair — Order 016-0698-00 ..... **$600**
Display Stand — Order 016-0717-00 ..... **$750**

Tektronix offers service training classes on the 4114B and 4114B30. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.

See the color enhanced refresh option in the reference section beginning on page 9.

OEM terms available on this product.

4116B/4116B30

Computer Display Terminal

Ultra-High Resolution Capability

Local Picture Segments

2-D Transforms

Refresh Support and Fast Redraw

Compatible with the Tektronix 4010, 4100 and 4110 Series Terminals

The 4116B is a Computer Display Terminal with High Resolution Capabilities

The 25 inch diagonal display is uniquely suited for displaying highly complex graphics due to its 4096 x 3120 viewable resolution and finely etched 10 mil-wide vectors. By using a DVST (Direct View Bistable Storage Tube) Display, lines are sharp, continuous, stable and flicker-free, making it easy to study the finer details of a map or design. The thumbwheel controlled crosshair cursor also makes it easy to interact precisely with the detail displayed on this size CRT.

Local intelligence and expandable memory significantly reduce the delays and costs that result from dependence on a host computer. The 4116B is compatible with the Tektronix 4010, 4100 and 4110 Series of Computer Display Terminals, as well as with graphics software in the Tektronix PLOT 10 IGL (Interactive Graphics Library).

Over 15,000 characters may be displayed simultaneously and may be formatted in 179 alphanumeric characters per line page (like a line printer), or as two 85-character per line pages (like an open book). Three other larger character formats are standard with the 4116B, the largest of which is suitable for group viewing.

Local Picture Segments

Using the 4116B's "local segments" capability, a group of graphic primitives describing a portion or segment of a picture may be retained as a unit in local memory to be quickly redrawn or manipulated at any time.

Definable Refresh Dialog Area

The dialog area lets the user define the size and location of a scrollable dialog area—all in refresh. This area can be redefined and repositioned at any time, assuring that the host terminal data traffic need never clutter the graphics workspace.

4116B30 Workstation

The 4116B can be configured either as a pedestal unit with detached low profile keyboard or in separate display, processing, and keyboard modules for flexibility in configuring workstations (4116B30).

CHARACTERISTICS

DATA TRANSMISSION

Data Rate — 19.2 kbaud.

Block Mode — Optional.

Communications Interface — RS-232C full or half duplex.

MEMORY

Standard — 288 k RAM.

DISPLAY

Medium — Direct view storage tube.

Size — 635 mm (25 in) diagonal.

KEYBOARD

Normal Keyboard — 72 typewriter paired upper and lower case, programmable and autorepeating (five lighted).

User Definable Programmable Function Keys — Eight.

Terminal Control Keys — Four.

Graphic Cursor Control — Thumbwheel.

GRAPHICS MODE

Addressability — 4096 x 4096 points.

Resolution — 4096 x 3120.

Line Types — Solid, dashed, defocused.

Graphic Command Syntax — PLOT 10 compatible.

Graphics Primitives — Vectors, user-defined text, etc.

Drawing Speed — Storage: 134 m/s; Refresh: 537 m/s.

ALPHANUMERIC MODE

Character Set — 94 (full ASCII). 128 displayable in "snoopy" mode.

Character Format — Stroke.

AC POWER

Line Frequency — 48 Hz to 62 Hz, 180 V ac to 260 V ac, 6.5 A max, or 48 Hz to 62 Hz, 90 V ac to 132 V ac 13 A max.

PHYSICAL CHARACTERISTICS

Dimensions	4116B		4116B30	
	mm	in	mm	in
Width	698	27.5	698	27.5
Height	1400	55.0	1295	51.0
Depth	813	32.0	85	33.5
Weights	**kg**	**lb**	**kg**	**lb**
Net	130.6	288.0	185.0	407.0

INCLUDED ACCESSORIES 4116B/4116B30

8 ft power cord (161-0123-00); 21 in pedestal to display power cable (161-0145-00); interconnect cable pedestal to display (012-1058-00); 12 ft host port RS-232 cable (012-0911-00); pkg of 6 function key overlays (334-3290-01); 4114B/4116B operator's manual; 4114B/4116B host programmer's manual; 4110 Series command reference manual; 4114B/4116B introduction brochure.

All accessories for the 4116B30 are the same as those for the 4116B, except for the following:

Display swivel base (016-0774-00); 10 ft pedestal to display power cable (161-0126-00); 10 ft pedestal to display interconnect cable (012-1058-00); 4110B30 Series desk configuration service manual.

ORDERING INFORMATION

4116B Computer Display Terminal ... **$22,400**

4116B30 Computer Display Terminal Workstation **$23,900**

Option 01 — Extended Communications ..... +$950
Option 4A — United Kingdom Keyboard ..... +$120
Option 4C — Swedish Keyboard ..... +$120
Option 4E — APL Keyboard ..... +$750
Option 4F — Danish/Norwegian Keyboard ..... +$120
Option 4K — Japanese (Katakana) Keyboard ..... +$120
Option 10 — Three-Port Peripheral Interface ..... +$1,200
Option 13 — 11 x 11 in Graphic Tablet with Pen .... +$2,950
Option 14 — 30 x 40 in Graphic Tablet with Pen .... +$4,950
Option 28 — Additional 256 Kbytes of RAM ..... +$2,300
Option 29 — Additional 512 Kbytes of RAM ..... +$4,600
Option 32 — Table Module (4116B30 only) ..... +$500
Option 41 — Ten-Slot Peripheral Bus Extender, 90-110 V Line Voltage ..... +$350
Option 42 — Single Flexible Disk and Disk Controller ..... +$1,700
Option 43 — Dual Flexible Disk and Disk Controller . +$2,600
Option 45 — Mass Storage Interface ..... +$1,500

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

WARRANTY-PLUS **SERVICE PLAN** **REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... +$1,070

OPTIONAL ACCESSORIES

4114B/4116B Service Manual Vol I
4114B/4116B Service Manual Vol II
Cal Fixture Loopback Connector — for Host-Port Test (RS-232) Order 067-1043-00 ..... **$17**
Cal Fixture Loop, Loopback Connector — Order 067-1042-00 ..... **$13**
Cal Fixture Extender Board — Order 067-1005-00 ..... **$300**
Cal Fixture Extender Cable — Order 067-1053-00 ..... **$140**
Media, Flexible Disk — Order 119-1376-01 ..... **$110**

All accessories for the 4116B30 are the same as those for the 4116B, except for the following:

Ergonomic Chair — Order 016-0698-00 ..... **$600**
Display Stand — Order 016-0717-00 ..... **$750**

OEM terms available on this product.

NEW

DISK DRIVES

4925 Dual Flexible Disk

4926 10 Megabyte Hard Disk

5 1/4-Inch Half-Height Drives

650 Kbyte Formatted Capacity (4925)

Media Transportability From 4170 to 4110 Series Terminals (4925)

Configurable with 5 1/4-Inch Winchester Hard Disk (4925)

Easy Integration Through a Standard Interface

Complements 4110 Series Terminals with Local Programmability (4926)

5 1/4-inch Winchester Technology

10 Megabyte Formatted Capacity (4926)

The 4925 is a flexible disk drive that supports compatibility between the 4170 Local Graphics Processing Unit and the 4110 Series terminals by providing a means of media interchangeability. The 4925 enables the 4110 Series terminals to accept files generated on the 5 1/4-inch flexible disks of the 4170.

The 4925 has dual half-height drives stacked on top of each other to minimize space requirements while providing as much capacity as possible. The drives are the same as those that are standard to the 4170. Dual half-height drives also provide back-up to each other. In case of failure of one drive, the other remains functional.

The 4926 is a 10 Mbyte hard disk drive that provides mass storage for 4110 Series terminals with local programmability. It gives users of 4110 Series terminals direct local access to large capacity mass storage, increasing applications flexibility and efficiency. The 4926 may also be configured with two optional flexible disks providing even more storage or removable media for backup.

Proven Winchester Technology

Sealed drive heads on the 4926 and media improve reliability and environmental protection, and reduce maintenance. Winchester technology also allows high capacity that lowers the cost per Mbyte to the user and provides the level of local data storage that interactive graphics requires. Fast access time further improves overall system effectiveness.

Configuration Flexibility

The disk drives in the 4925 may be configured with other Tektronix 5 1/4-inch storage devices. Since two-wide packaging is used across several Tektronix products, these flexible disk drives can be housed in the same cabinet as the 4926 10 Mbyte (Megabyte) hard disk. The resulting configuration is the 4926 Option 25. It provides packaging economies and built-in back-up media for the hard disk so important files can be removed.

The 4926 has 10 Mbytes formatted capacity, and additional 10 Mbyte increments can be readily added. Each 4926 cabinet can house two drives, and the second drive requires no change in the unit's power supply, controller, or interface hardware.

The level of terminal operating system in use will define the limit to the number of drives addressable.

Interfacing Uses a New Tektronix Standard

Directly connecting to the intelligent Mass Storage Interface of the terminal makes interfacing simple. The MSIB (Mass Storage Interface Bus) is the Tektronix implementation of the popular SCSI (Small Computer Systems Interface) specification (described in ANSI X3T9.2/82.2). Since the bus allows multiple mass storage devices, the 4925 can easily be added to a system. If another device, such as the 4926, is already configured, the 4925 uses the same interface with no additional cost. The MSIB allows seven controller slots, so even more devices can be added as application needs expand, subject to terminal operating system limits on device addressability.

CHARACTERISTICS

The following characteristics apply to both the 4925 and 4926 unless otherwise noted.

Capacity

4925: Unformatted is 1 Mbyte (500 kbytes each). Formatted is 654 kbytes (327 kbytes each).

4926: Unformatted is 12.76 Mbytes. Formatted is 10.0 Mbytes.

Access Times

4925: Average is 93 ms. Track to Track is 6 ms.

4926: Average Access Time is 85 ms. Track-to-Track is 3 ms.

Recording Surfaces — Two/drive, double-sided (4925).

Recording Format — Double density, 5876 bits/in (4925).

Track Density — 48/in (4925).

Average Latency — 8.3 ms (4926).

Data Transfer Rate

4925: 100 kbytes/s max burst rate.

4926: 10.2 kbytes/s max burst rate.

Error Rates — Recoverable (soft): 1 in 10^9 bits. Nonrecoverable (hard): 1 in 10^{12} bits.

Interfacing — MSIB which is the Tektronix implementation of the SCSI described in ANSI document X3T9.2/82.2.

AC POWER

Power Requirements — 100 V ac to 125 V ac at 2 A; 180 V ac to 240 V ac at 1 A; 50 to 60 Hz.

Power Consumption — 140 W max.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	368	14.5
Height	128	5.0
Depth	433	17.1
Weight	**kg**	**lb**
Net	6.4	14.0

INCLUDED ACCESSORIES

Power cable (161-0066-00); 6.5 ft 2 meter MSIB cable (Mass Storage Interface Bus) (012-0037-00); instruction manual.

ORDERING INFORMATION

4925 Dual 5 1/4-Inch Flexible Disk Drive . **$2,200**

4926 10 Mbyte Hard Disk **$4,200**

Option 25 — (4926) Dual 5 1/4 in Flexible Disk; also Field Installable (Kit Number 4926F25) ..... **+$1,600**

Option 26 — (4926) Additional 10 Mbyte Hard Disk Drive; also Field Installable (Kit Number 4926F26) ..... **+$2,200**

Option 49 — Rental Tag ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$210**

OPTIONAL ACCESSORIES

Remote Power Cable (BNC) — (4925 and 4926) Order 012-0476-00 ..... **$23**

Diskettes — Pkg of 10 Order 119-1583-01 ..... **$55**

OEM terms available on these products.

NEW

4970/4970P01/4970P02

Cluster Controller

IBM SNA/SDLC Compatibility

The 4970 Cluster Controller with 4970P01 or 4970P02 Software Provides 3270 Type Data Communications

4970P02 Provides 3270 Full Screen Emulation

The 4970 Cluster Controller and Companion Software Allow Tektronix Graphics Terminal Users to Access SNA, Multihost Environments

Communicating to the host like an IBM 3274 or 3276 Terminal Controller, the 4970 accepts asynchronous data (at rates up to 19.2 kbps) from as many as four Tek asynchronous ASCII terminals and converges it to a single synchronous EBCDIC data stream transmitted at data rates up to 9,600 bps. With 4970P02 software Tek terminals can be used in 3270 full screen alphanumeric applica-tions.

Increased Communications Efficiency

The 4970 reduces transmission line and port costs, since the 4970 system allows Tek graphics terminals to operate in a polled environment. Higher data rates (up to 9,600 bps) improve system response to the user.

Error Free Graphics

Network (SNA) error recovery is automatic, and since SDLC provides error checking, data integrity is assured at the link level.

4970 Key Features

Microprocessor Driven with Intel 8086

128 kbyte RAM Memory for Program Storage and Buffers. Communications Parameters Stored in Battery-Powered CMOS Memory.

All Electrical Components have Tektronix' Reliability and Service--MTBF (Mean Time Between Failures) is 7000 Hours.

Communication Between the 4970 and Connected Terminals is Asynchronous ASCII, with Either DC1/DC3 or DTR/CTS Flagging.

Power Up and Extended Self-Test Programs Assure Positive Problem Determination.

The 4970 Cluster Controller and terminals are installed and supported as though they were 3270 devices. Sysgen is the same for the 4970 and the SNA Physical Unit 2. There is no need for teleprocessing software modifications.

CHARACTERISTICS

HOST INTERFACE

Mode — Synchronous.

Baud Rate — 300 bps to 9.6 kbps through synchronous modems or in direct connect mode using 4970 clock.

Code — EBCDIC.

Link Protocol — SDLC.

Network Compatibility — SNA Physical Unit (PU) type 2; the 4970 looks like an IBM 3274 or 3276 to the host.

Communication Media Supported — Leased line/dial-up.

TERMINAL SUPPORT

Mode — Asynchronous.

Baud Rate — Selectable: 300 bps, 1200 bps, 2400 bps, 4800 bps, 9600 bps and 19.2 kbps.

Code — ASCII.

Flagging — DC1/DC3 or CTS/DTR.

SELF-TEST CAPABILITY

Power-up — Self-test routine.

User-Initiated — Extended self-test including DCE and DTE loopback for fault isolation.

Stress Test — Maximum/minimum voltage.

DC 100 TAPE DRIVE

For protocol program loading and creating back-up tapes.

COMMUNICATIONS PARAMETERS

Method of Entry — Password-protected monitor port in back panel.

Parameter Volatility — Battery-maintained CMOS maintains parameters through power-downs or outages.

User-Selectable Parameters — Controller address (from C1 to C9), terminal baud rate, echo, flagging mode, end-of-message (EOM) character, message size, controller S/N (for dial-up connection).

FRONT PANEL INDICATORS

Port Status — One LED for each terminal.

Host Status — One LED each for: Carrier Detect (CD), T-Data, R-Data, Error.

Ac Power — On/off.

AC POWER

Power Requirements — 130 W max.

Line Frequency — 48 Hz to 62 Hz.

Voltage Fuse — Low Range: 90 V ac to 125 V ac, 2.5 A fast blow fuse. High Range: 175 V ac to 250 V ac, 1.5 A fast blow fuse.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	406	16.0
Height	133	5.3
Depth	483	19.0
Weight ≈	**kg**	**lb**
Net	8.6	19.0

INCLUDED ACCESSORIES

Power cord (161-0066-00); 12 ft RS-232 modem I/F cable (012-0911-00); DTE loopback test adaptor (013-0211-00); DCE loopback test adaptor (013-0212-00); instruction sheet; user guide.

ORDERING INFORMATION

4970 Cluster Controller **$5,100**

4970P01 SNA/SDLC/3270 Controller Software **$750**

4970P02 3270 Emulation SNA/SDLC Controller Software **$1,100**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

WARRANTY-PLUS **SERVICE PLAN** **REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$215**

OPTIONAL ACCESSORIES

Blank DC 100 Tape Cartridge —
Order 119-1350-00 ..... **$25**
Service Manual
User Guide

NEW

LOCAL PROGRAMMABILITY

Local Programmability

For 4110 Series

Stand-Alone Intelligence for 4110 Series Terminals

Local Access to Graphics Manipulation Capabilities

CP/M-86

Fortran-86

Local IGL

The 4110 Series Local Programmability gives 4110 Series terminals independence from the host processor by equipping them with local intelligence and processing power. Local Programmability supplies the elements needed to locally develop and run programs; to access all the graphic and alphanumeric features resident in the 4110A or 4110B Series firmware; and to control peripherals connected to the terminal.

The package consists of a disk-based CP/M-86 operating system, FORTRAN-86 compiler or ASM-86 macro assembler, utility programs and a library of DTI (Direct Terminal Interface) subroutines. Optionally, a local version of Tektronix' PLOT 10 IGL (Interactive Graphics Library is also available.

Distributed Processing for Graphics Applications

Local Programmability has the capability to run entire programs locally. Since some applications may require the computational capabilities or data base management of a mainframe computer, the terminal also can be used on a stand-alone basis for the pre-and post-processing of graphics information.

By promoting more efficient use of the host system, Local Programmability cuts costly host-connect and host CPU time. The host is freed to do the processing for which it is best suited, while terminal-based processing yields faster response time and increased user productivity. Distributed processing also frees the host to support more terminals.

Even if a host computer is unavailable, Local Programmability enables the terminal to be used as a stand-alone unit to run or develop programs. Many applications in mapping, CAD/CAM, data analysis and graphing can be written and run locally on a 4110B Series terminal without host support.

Local Access to Terminal-Resident Graphics Functions

The DTI is a library of FORTRAN-callable subroutines that correspond directly to each of the terminal's functions. DTI affords a quick and efficient path to the terminal's firmware while occupying a minimum of memory (5 kbytes to 25 kbytes). Object code for the entire DTI library requires only 60 kbytes of disk space, freeing mass storage for other system and application programs.

The DTI enables the FORTRAN programmer to exercise all 4110A or 4110B Series features by calling the appropriate DTI subroutines. While each 4110A or 4110B Series terminal provides capabilities unique to its display type such as color raster, monochrome raster or DVST, significant graphics features common to all include local picture segments and a scrollable dialog area.

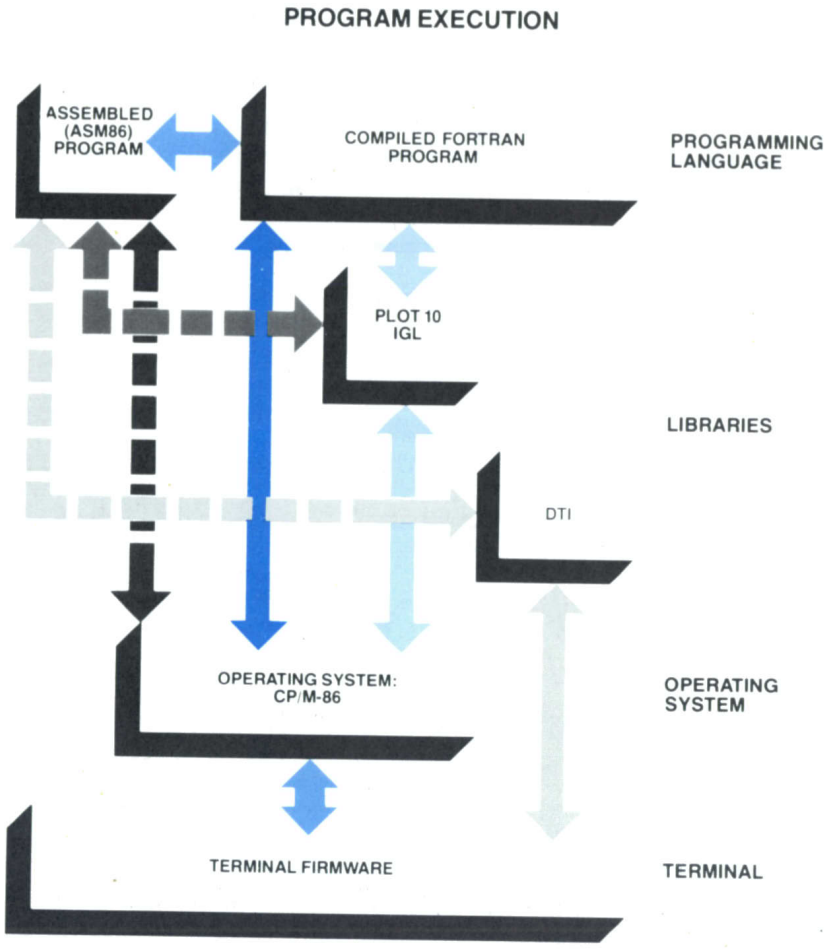
Local IGL

A local version of Tektronix' PLOT 10 IGL is available to 4110A or 4110B Series terminals via Local Programmability. Existing host programs that call IGL routines can be run locally on 4110A or 4110B Series terminals. The user simply downloads the program source file to the terminal, compiles the program and links it with the Local IGL.

Local IGL also allows software designers to develop application programs on a 4110A or 4110B terminal, which can be run with other Tektronix terminals (such as the 4010 or 4020 Series). After an application is written on a 4110A or 4110B Series terminal, it is uploaded to the host, compiled and linked to the host-resident IGL, which contains the 4010/4020 terminal device drivers.

Local IGL provides the flexibility to choose where to run an application without modifying the application program i.e. most efficiently on the host, the terminal or a combination of the two.

Based on SIGGRAPH's proposed core system of computer graphics standards, Local IGL consists of a Primary Command Set, which contains the fundamental routines needed to do graphics. Other modules include advanced features such as Two-Dimensional Graphic Text Composition and Emulation and Three-Dimensional Graphics.



Relationship of Local Programmability Software

FORTRAN-86 Program Development

FORTRAN-86 is the best available local version of FORTRAN, the most commonly used and popular programming language for graphics. Programs may also be developed using a standard assembler (ASM-86) or a macro assembler (ASM-86).

FORTRAN-86 is a superset of the FORTRAN 77 subset defined by the ANSI (American National Standards Institute). Most existing FORTRAN programs can be compiled and run under FORTRAN-86 with little or no modification, thus preserving the user's software investment.

FORTRAN-86 takes advantage of the 8087 numeric co-processor, which performs floating point operations. By complementing the terminal's 8086 CPU, the 8087 yields execution speeds which exceed those of many minicomputers and much faster than possible with the 8086 alone.

CP/M-86 For System Growth, Software Compatibility

The industry-standard CP/M-86 operating system gives the Local Programmability unit extreme latitude in system growth and extreme breadth in Tektronix and third-party software.

CP/M-86 is designed for single-user, single-task environments, but Tek's unique implementation of CP/M-86 allows it to reside as a single-task system within a multitasking environment, sharing the 8086 with standard terminal firmware functions. CP/M-86 allows the user to create and manipulate files, manage disk storage, control peripherals and execute programs. It also gives the user access to a broad range of existent CP/M-86-based software.

Standard CP/M-86 utilities are supplemented by Tektronix-developed programs, including BATCH, HOST and SPOOL. BATCH allows unattended execution of complex sequences. HOST allows the user to transmit a file from the terminal to the host system (uploading) or receive data from the host and write it to a file on the terminal (downloading). SPOOL maximizes terminal operations by simultaneously allowing files to be sent to a host or peripheral while the terminal performs other functions.

Series-Wide Compatibility

Local Programmability will run on all 4110A or 4110B Series terminals, the 4115B terminal, and on earlier 4110 Series terminals that have been field-upgraded to "A" version status. The recommended system configuration includes a minimum of 256 kbytes of RAM. The user can expand local memory up to a total of 672 kbytes on the 4113A or 4113B, 800 kbytes on a 4114A or 4114B, 4116A or 4116B, or 4115B and up to 500 kbytes on the 4112A or 4112B.

For program development the terminal needs two functional disk drives. This functionality can be provided by selecting either one flexible disk drive with "M-Disk" capability (for 4112A or 4112B); two flexible disk drives; or one flexible disk drive and one Winchester disk drive. Each eight inch flexible disk provides up to 494 kbytes of file storage. The Winchester drive contains a nonremovable hard disk that is five to fourteen inches in diameter and stores up to 10 Mbytes of data.

Optimization of Terminal-Resident Graphics Capabilities

Local Programmability provides all the elements necessary to fully develop and run programs on 4110A or 4110B Series terminals.

PLOT 10 IGL offers a rich set of graphics tools, while the DTI gives the user control of the terminal's firmware. Local Programmability has been specifically designed to fully optimize the graphics capabilities of the 4110A or 4110B Series Computer Display Terminals.

CHARACTERISTICS

GENERAL INFORMATION

Memory Requirements — 256 kbytes.

Equipment Requirements — 4110A or 4110B Series computer display terminal. Dual disk functionality provided by any of the following: Dual Floppy Disk Drives, Floppy Disk and Winchester Drive, Dual Winchester Drives, Single Floppy Drive and M-Drive Program. Program execution requires at least a single disk drive and sufficient memory to run the program.

ORDERING INFORMATION

Note: Prices are approximate depending on options.

4100P01 CP/M-86 w/DTI & FORTRAN; S*L*R, QRO **$1,000**

4100P02 CP/M-86 Assemblers S*L*R, QRO **$1,000**

4100P11 CP/M-86 FORTRAN (Intel FORTRAN-86); S*L*R, QRO **$500**

4100P12 CP/M-86 Assemblers (Intel FORTRAN-86), S*L*R, QRO **$500**

A variety of offerings and options are available. Please contact your nearest Tektronix sales office for complete information.

Tektronix offers user-training classes on Local Programmability. For further information, contact the Customer Training Registrar at (503) 685-3808 or your nearest Tektronix sales office.

NEW

GATE ARRAY LAYOUT SYSTEM

MERLYN-G

Automatic Placement and Routing

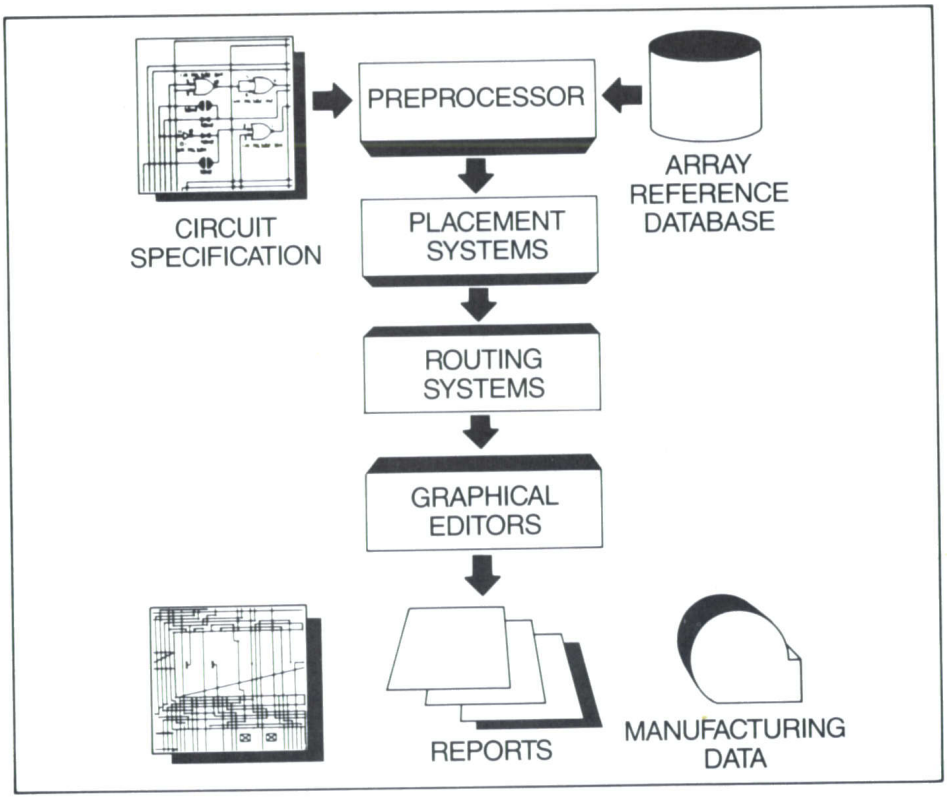
Array Style and Technology Independent

Highly Transportable

Expandable Capacity (100-10,000 Gates)

Automatic Connectivity and Design Rule Verification

Interactive Graphical Layout Editors



Automated Gate Array Layout

MERLYN-G is a fully automated physical layout system for personalizing gate arrays. It automatically performs all of the layout functions such as cell/macro placement, routing, and wire path optimization using sophisticated state-of-the-art algorithms. Additionally, MERLYN-G has graphical editing facilities that allow the designer to interactively modify the layout.

MERLYN-G provides a variety of benefits to the gate array designer including:

- Rapid Turn-Around of Designs
- Consistent Application of Design Rules
- Support for new array styles and technologies
- Strong technical support, maintenance, and ongoing enhancements

Array Personalization Process

MERLYN-G uses a reference data base to store individual cell/macro descriptions and the general array specifications. The actual array personalization information (i.e., circuit specification) is entered as a free-format text file. The file can be automatically generated from a commercially available schematic capture system, or it can be created manually with a text editor. The MERLYN-G PREPROCESSOR combines the circuit specification with the relevant reference information to produce a machine-readable design file which can be manipulated by MERLYN-G.

MERLYN-G calculates a suitable placement for the cells used in the array, and then routes the interconnection wiring. Multiphase placement and routing strategies are used to produce the best possible layout. After layout, MERLYN-G generates checkplots, descriptive reports, and data files compatible with major manufacturing systems (e.g., CALMA, etc.).

Fully Automatic Placement and Routing

The MERLYN-G layout system is truly an automatic system. As long as a design does not exceed the autoroutable cell utilization limit (typically 70%-85% for an average array), no designer intervention in the layout process is required. Available cell utilization can be increased to greater than 90% when interactive editing techniques are used (depending on the complexity of the circuit).

Array Style and Technology Independance

MERLYN-G has a proven track record in laying out the major array technologies (including CMOS, ECL, I^2L, STL, etc.) It supports almost any array topology using any set of design rules. Further, VR actively maintains active technical liaison with the major array vendors to ensure that MERLYN-G will continue to support the latest technology.

Highly Transportable

The MERLYN-G system is a highly transportable system written in ANSI standard FORTRAN 66. Both object and source code (United States only) licenses are available. The system is currently installed and running on superminis (DEC/VAX, HARRIS, PRIME) as well as mainframes (IBM, NAS, Amdahl).

Expandable Capacity (100 to 10,000 Gates)

The MERLYN-G system has a modular configurable architecture that allows the designer to expand the capabilities of his system in step with his needs and expanding computer power. This feature protects your investment in layout tools by ensuring that they will always match the task to be done and the available computing power.

Automatic Connectivity and Design Rule Verification

MERLYN-G has special facilities for verifying net connectivity and testing for shorts or design rule violations. They can be executed as part of the automatic layout sequence or as part of the interactive graphical editing procedures.

Extensive Support and User Training

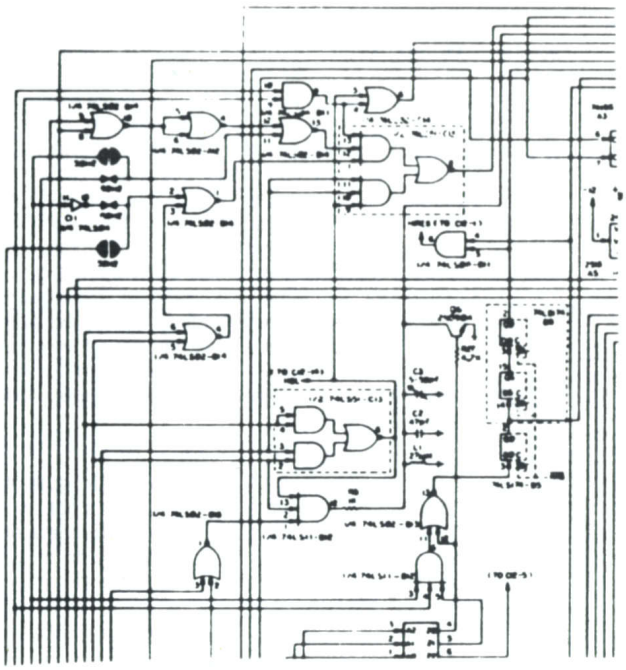
MERLYN-G training is performed at the user's site and includes formal classroom instruction, demonstration exercises, and hands-on assistance with the user's own design problems. Optional sustaining technical support is available including periodic system updates as well as access to VR's customer support staff.

System Environment

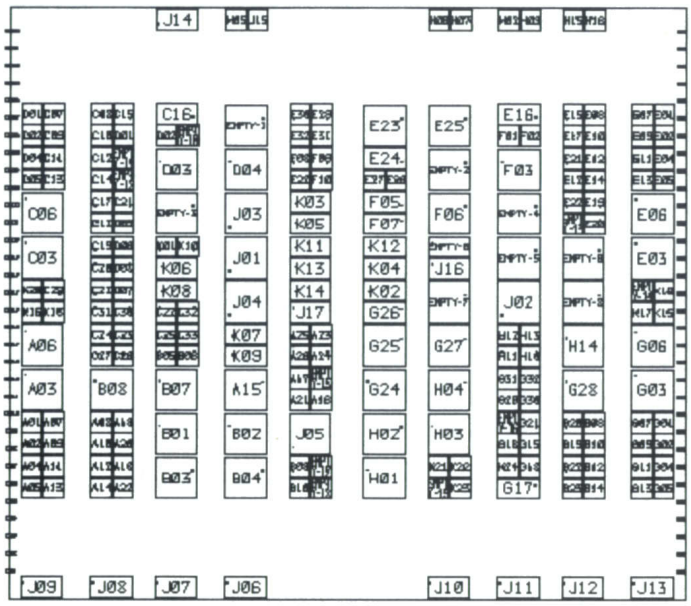
The MERLYN-G system currently runs in a variety of hardware and operating system environments. The following specifications describe the required operating environment.

COMPILER	FORTRAN 66
PHYSICAL MEMORY	2 Mb minimum
OPERATING SYSTEM	Virtual (4 to 12 Mb)
DISK CAPACITY	140 Mb or more
CODE TRANSFER	Magnetic Tape
GRAPHICS TERMINALS	Tektronix
PLOTTERS	Versatek, Nicolet, Tektronix Zeta, Gerber, etc.

NEW

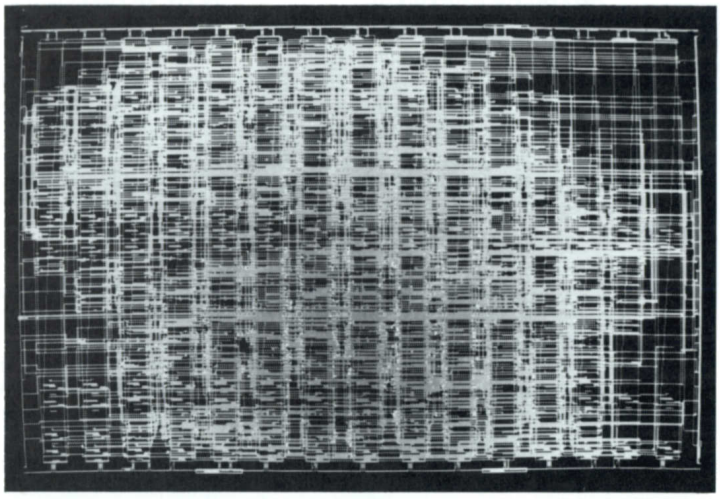


Specification Capture
The MERLYN-G circuit specification contains the cell/macro list and net list of a given personalization. This information can be captured automatically from a schematic capture system or logic simulator, or it can be generated manually.

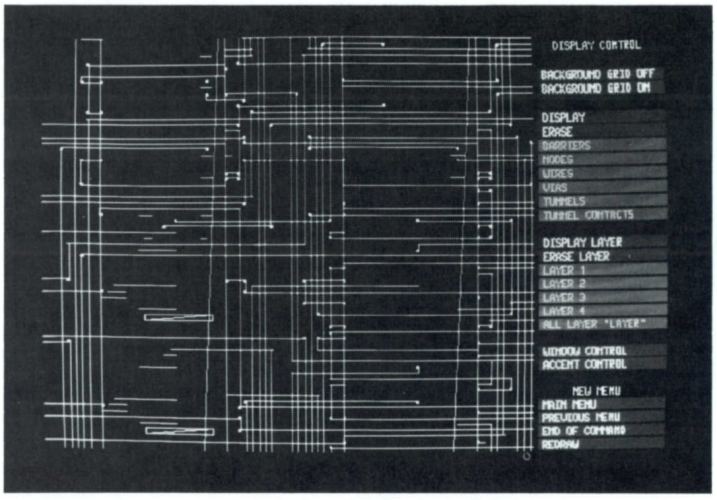


Placement
MERLYN-G has a variety of tools to perform cell/macro placement and placement improvement functions. There are initial placers, automatic placement improvement tools, and interactive graphical placement editors. MERLYN-G placers initially locate cells/macros on the array and then rearrange their locations to enhance routing completion.

If you would like further information about the MERLYN-G gate array layout system as it applies to your particular design needs, please call VR Information systems (a wholly owned subsidiary of Tektronix, Inc.)



Routing
MERLYN-G has a variety of routing systems to accomodate various array styles. The BASIC CHANNEL ROUTER is used to route simple row/column style arrays. The ADVANCED CHANNEL ROUTER routes complex arrays with intersecting channels. Also, there are special routing tools for particularly difficult probems, including the MAZE ROUTER for barrier strewn topologies and the RIPUP AND RETRY ROUTER for isolated nodes.



Interactive Editing
MERLYN-G has dynamic on-line layout editing facilities for both placement and wiring. A GRAPHICAL PLACEMENT EDITOR allows the designer to interactively modify placement, and A GRAPHICAL WIRE EDITOR allows the designer to interactively modify wiring.

For further information about the MERLYN-G gate array layout system as it applies to your particular design needs, please contact VR Information systems (a wholly owned subsidiary of Tektronix, Inc.)

VR Information Systems, Inc.
5818 Balcones Drive
Austin, Texas 78731
Phone: (512) 458-8131
TLX: 910-874-2052

GRAPHICS SOFTWARE

Tektronix has been setting graphics standards for over a decade. Our new products reflect the implementation of the evolving international standards and the concepts that underlie those standards—software portability and device independence. The goal is to protect your software investment and provide a hardware growth path, and Tek software is designed to meet your changing needs.

Tektronix offers PLOT 10 products to make that goal a reality. PLOT 10 software takes advantage of the graphic capabilities of the 4010, 4020, 4110 and the new 4100 Series Computer Display Terminals together with our plotters and color copiers. It includes tools that perform basic graphic functions, create sophisticated applications employing many graphics concepts and graph making for report generation.

PLOT 10 consists of five software libraries, each optimized for different graphics applications: Terminal Control System, Interactive Graphics Library, Easy Graphing II and the latest offerings, PLOT 10 Graphical Kernel System and PLOT 10 Vector/Raster utility.

PLOT 10 Terminal Control System

TCS contains the basic building blocks for graphics operations for all levels of sophistication on Tektronix DVST terminals, the 4105 color terminal and 4660 series plotters. This library of FORTRAN IV subroutines allows system-independent graphics programming. The experienced programmer can work at the terminal level to develop new applications or interface to existing programs. At the same time, the more casual user can work easily at the conceptual level to create quality graphics.

PLOT 10 Interactive Graphics Library

PLOT 10 IGL is Tektronix version of the SIGGRAPH Core package. IGL is a host and device independent library of routines for graphics and text interaction in two or three dimensional space. IGL is feature matched to the intelligence and local processing power of 4100 series terminals. Both local and host picture segment processing is supported, offering upward and downward application compatibility across Tektronix terminal product lines.

PLOT 10 Easy Graphing II

Easy Graphing II has a straight-forward English language command structure that offers the non-programmer a wide range of graphing functions in engineering and business environments. Programmers can also use the product to design customized graphical displays for their unique data handling requirements. Easy Graphing II features low-cost operation with high-quality graphing for reports or group presentation.

PLOT 10 Graphical Kernel System

PLOT 10 GKS is a full implementation of ISO and ANSI's proposed international standard, the Graphical Kernel System (GKS) Level 2B. To the experienced graphics programmer, PLOT 10 GKS is a natural evolution of tools that requires only an orientation experience. To the new programmer, it supplies all the tools needed to manipulate graphic segments, software text fonts, standard digitizing input functions and multiple windows and viewports.

Implemented as a library of ANSI FORTRAN '77 graphics subroutines, PLOT 10 GKS is a development tool an applications programmer can use to create graphics programs without regard for operating system or device specifics. PLOT 10 GKS is a high level graphics application development tool that describes graphics operations generally while working in a recognized standard syntax (a specified set of subroutine call names). This improves programmer productivity while it provides source code portability. The standardized calling conventions make it possible to transport programs across a wide spectrum of computer operating systems.

GKS incorporates the concept of multiple workstations by supporting a Window/Viewport on each workstation. Then each workstation (defined as an active display or input device) can have its own "bundle" of display attributes such as linestyle, line color or character geometry, set to take advantage of specific device characteristics. The application program can dynamically assign input and output devices without having to reset display attributes.

PLOT 10 Vector/Raster Utility

PLOT 10 Vector/Raster Utility is a FORTRAN software package designed to run on DEC VAX VMS systems. This product provides the ability to produce a picture utilizing the full 150 dpi resolution of the 4691 color copier.

The PLOT 10 VRU package may accept picture files from non-PLOT 10 software packages via a straight foreward disk file format. However, PLOT 10 IGL now has a device driver which will produce a picture file tuned especially for the VRU package. Compose your images interactively with PLOT 10 IGL on any Tektronix interactive graphics terminal and print them in full color and high resolution on a Tektronix 4691 color copier.

Peripheral Support for Device-Independent Graphics

PLOT 10 products are packaged with device drivers for graphics hardware products; applications can be written without concern for the physical attributes of a device because the specifics reside in these device-dependent software modules. Many non-Tektronix products are advertising PLOT 10 compatibility; a special driver may not even be needed. PLOT 10 GKS includes drivers for Tektronix terminals, plotters and digitizing tablets. In addition, a device driver model and its documentation are provided offering the professional programmer a tool to develop drivers for non-Tek devices. PLOT 10 IGL also includes a full complement of device drivers to support the entire 4100 line.

Software Portability

Portability has always been the ultimate goal of the graphics standards efforts. Now it is not only possible to transport applications to a variety of host computers, but it is also possible to move applications to workstations using local programmability. Implementations of PLOT 10 TCS (the Terminal Control System that provides the basic graphics building blocks) PLOT 10 IGL and Easy Graphing II (a graphing package based on English language commands) are available locally on 4100 series units. Recently announced options add advanced capabilities to the local version of IGL including line smoothing and 3-D graphics routines providing the power of mainframes computer graphics with the benefits of local programmability. An important feature of local programmability means enhanced interactivity at local processor speed rather than data communication line rates.

Existing applications on the host can be downloaded and run locally, thereby increasing interactivity and saving storage costs.

Software Support

When you buy Tektronix software, you are also investing in the people and services behind the product. A Software Subscription Service (SSS) provides current releases of Tek licensed software products, updates to the documentation, along with additional information on applications and enhancements. The Technical Assistance Services (TAS) are designed to supplement your own resources and to provide training as well as short-term consulting during your software implementation. These combined programs help you get maximum benefit from your Tektronix software products.

Product overviews and specification data follows. We invite you to ask your local Tektronix Sales Engineer for a demonstration. Or, simply indicate your interest on the enclosed reply card.

PLOT 10

Graphics Software Library

PLOT 10 products provide tools for easy use of the graphic and alphanumeric capabilities of Tektronix terminals including the 4100, 4110 and 4010 Series terminals, 4006-1, 4025A and 4027A Color Display.

PLOT 10 is the world's leading commercial graphics library. Versatile, modular, and fully documented, it lets you start with only the code you need to do your job, then expand with modules and utilities to develop more sophisticated or specialized applications. PLOT 10 builds to high-level, "cookbook" solutions such as English-like commands for business applications and other nonprogrammer environments.

PLOT 10 Includes the Following Packages

TCS (Terminal Control System)

A composite of FORTRAN IV subroutines, TCS contains the basic building blocks for all graphic operations. Anything that can be displayed graphically can be managed by TCS. Its proven uses range from simple business graphs and forecast diagrams to contour maps of electron densities, interactive design of electrical circuit boards, and complex architectural renderings. Several sets of graphs and data can be displayed on-screen at once by using the system's windowing functions, or graphs can be superimposed in the same screen area. It permits modular as well as system independent programming, and supports such basic graphic functions as windowing, clipping and rotation for DVST terminals and 4660 Series plotters.

Plotter Utility Routines

These routines link your data base, terminal, TCS and Tektronix 4660 Series plotters to enable easy, powerful command of multicolored graphs, charts, maps and renderings. Digitizing is just as versatile by using the built-in joystick.

Advanced Graphing II Package

Versatile Terminal Control System software to graph your data using a powerful set of FORTRAN IV subroutines. AG-II combines simplicity of use with highly flexible subroutines to let a programmer tailor the size, shape and format of graphs, by specifying more than 40 graphic elements. AG-II is as much a boon to the new user as to the expert. By using the system's built-in default determinations, you can supply as few as two subroutine calls to produce a full-screen graph properly scaled and annotated.

Easy Graphing II

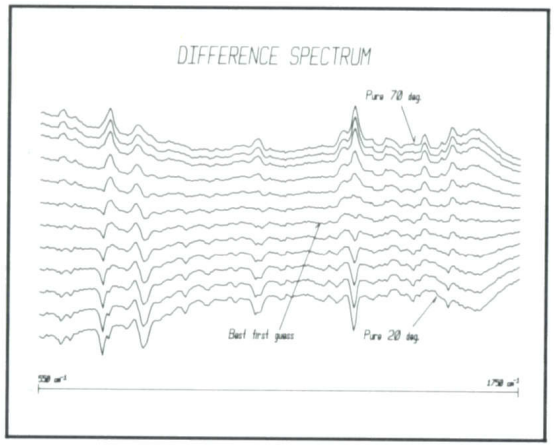
A straight forward English language command structure that gives the nonprogrammer wide-ranging command of graphics in business and engineering decision-making tasks. For those with programming experience, commands are provided to call user-written subroutines for customized graphical displays or for unique data handling requirements. The standard PLOT 10 Easy Graphing II package offers support for up to six curves or shaded bar charts, line graphs with special symbols and dashed lines, legends, titles, grids, hard copy, plotter control, and much more.

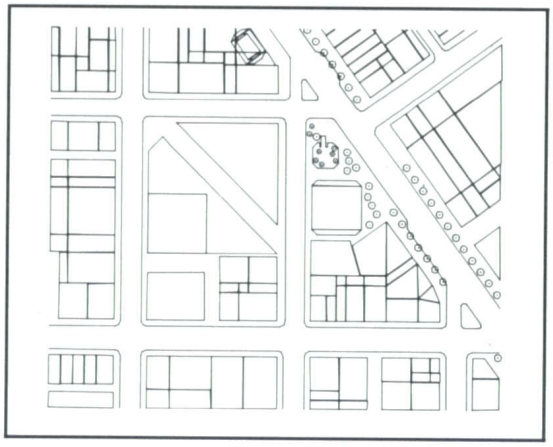
Vector/Raster Utility

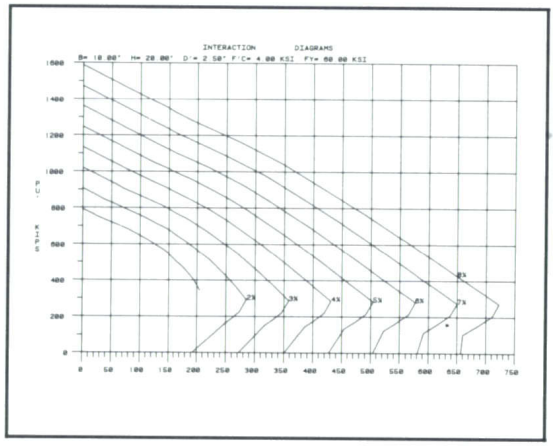
The PLOT 10 VRU (Vector/Raster Utility) (4000P50) is a FORTRAN software package designed to run on VAX VMS systems. The package consists of a Rasterizer program and an Output Spooler program.

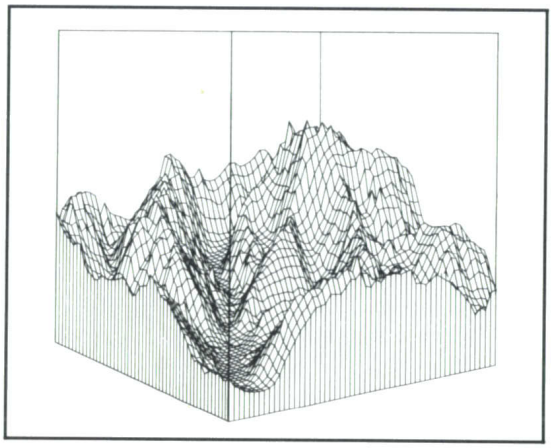
Pictures can be generated by PLOT 10 IGL (Interactive Graphics Library), PLOT 10 GKS (Graphical Kernel System) or any other program that produces an input file compatible with the VRU. The VRU Users Manual includes information on input file format requirements.

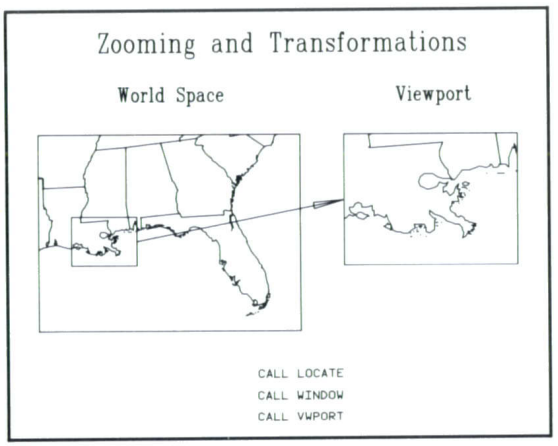
Since VRU is color oriented, even monochrome terminals can produce a high resolution, full-color display on a 4691. Any IGL or GKS generated picture (including panels, text and 3D) can be rasterized and displayed on a 4691.

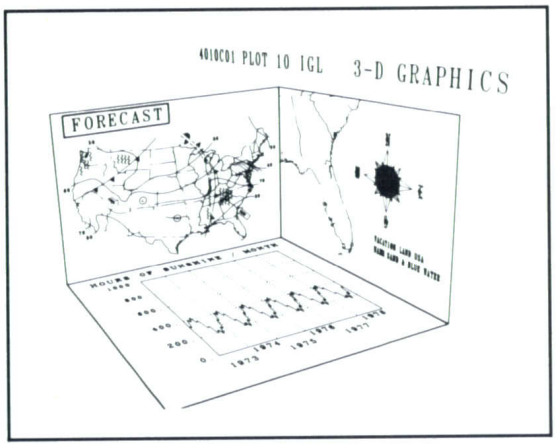


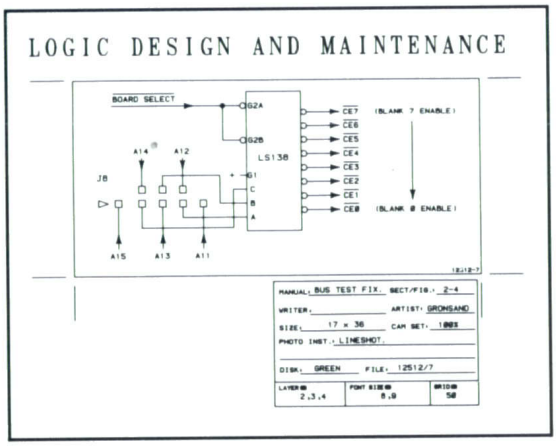


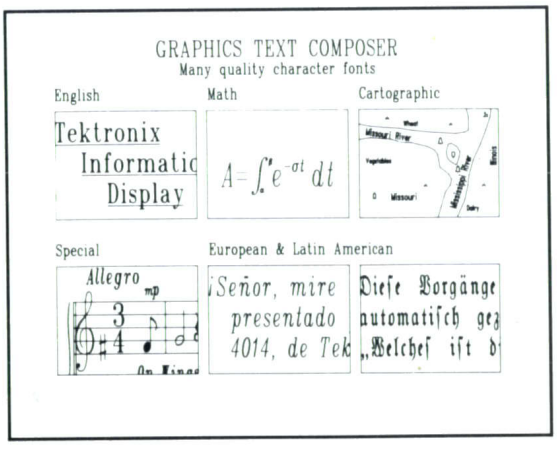












Graphical Kernel System

The PLOT 10 Graphical Kernel System (4000P70) is a FORTRAN '77 implementation of GKS at level 2B. GKS is the first international standard for computer graphics with language binding to FORTRAN '77. An application written for one version of GKS will run on any other of the same or higher level. GKS is device independent using device drivers to adapt to the display at hand. Colored lines, panels, multiple text fonts and graphic segments are included in PLOT 10 GKS. Each display surface, or workstation to GKS, may have its own set of attribute bundles. A programmer will find it easier to produce applications requiring interaction with separate windows and viewports with the tools in GKS. A metafile concept is included for storage and retrieval of drawings in a device independent manner. New 2-D applications will benefit from the strong engineering of this product, designed to meet the specifications of the first international graphics standard.

Interactive Graphics Library

IGL is a uniquely modular system of I/O, device drivers, primary commands and advanced feature support that lets the user move at will among any Tektronix display devices or technology. The structure of PLOT 10 Interactive Graphics Library follows the concepts suggested in the ACM/SIGGRAPH study on a core standard for computer graphics. Advanced options such as Line Smoothing, Color Panel Support, Graphics Text Composer, Segments and 3-D graphics may be added. Device drivers are included in PLOT 10 IGL for 4010, 4020, and 4100 Series terminals and 4660 Series plotters. A model device driver is also included for adaptation to non-Tek displays.

Subsets of PLOT 10 IGL features may be generated from our standard configurations to better match specific application requirements. Host computer and display device independance attributes of PLOT 10 IGL make it an excellent choice for 3-D graphics applications.

Local or Host

PLOT 10 GKS is available in ANSI FORTRAN '77 source form. PLOT 10 TCS, PLOT 10 Easy Graphing II and PLOT 10 IGL are available in FORTRAN source form for host mainframe computers or in object code form to run on 4100 Series terminals with CP/M-86.

ORDERING INFORMATION

Note: Prices are approximate depending on options.

"A" Series, Matching Software for DVST Terminals.

4010A01 — PLOT 10 Terminal Control System **$1,900**
4010A02 — PLOT 10 Advanced Graphing II **$2,200**
4010A04 — PLOT 10 Preview Routines for CalComp Plotters **$550**
4010A05 — PLOT 10 Character Generation System **$250**
4010A06 — PLOT 10 Graphic Tablet Utility Routines **$220**
4010A10 — PLOT 10 Terminal Control System, Implementation for IBM with TSO **$2,200**
4010A14 — PLOT 10 Intelligent Graphics Enhancement Routines **$385**
4010A15 — PLOT 10 TCS/IGL Bridge **$500**
4662A01 — PLOT 10 Utility Routines **$460**
4663A01 — PLOT 10 Utility Routines **$750**

"B" Series, Office Machine Simplicity for Producing the Most Popular Formats in Graphing.

4010B06 — PLOT 10 Easy Graphing II **$2,600**

"C" Series, The Graphic Standard in Device Independence.

4010C01 — PLOT 10 Interactive Graphics Library ..... **$4,000-$17,000**
4010C02 — PLOT 10 Preview Routines **$1,000**

"Color Rasterizing Software"

4000P50 — PLOT 10 Vector/Raster Utility **$3,000**

"International Standard"

4000P70 — PLOT 10 Graphical Kernel System **$8,000**

Tektronix offers user training classes on PLOT 10 IGL. For further information, contact the Customer Training Registrar at (503) 685-3808, or your nearest Tektronix office.

PLOT 10 GKS classes begin June 1984.

PLOT 50

Graphics Software Library

PLOT 50 software supports the 4050 Series Desktop Computers. The PLOT 50 software provides flexible, interactive programs that aid the user in scientific, engineering and management applications through easy-to-use high quality graphics.

Tektronix has developed an extensive library of software to assist users with their multiple applications.

MicroPERT 2 - Project Management

This (tape or disk based) software package represents an innovative approach to understanding changes in complex projects. PERT and CPM (Critical Path Method) techniques are employed as well as many options for graphic reports, responsibility coding and resource utilization and management.

Project managers can obtain faster turn-around when making project changes and graphically understanding the results of those changes.

Interactive Digitizing

This sophisticated software package is intended for users in "production" digitizing environments. Users can quickly create and edit digitized files for analysis and processing. The software is tablet menu driven with assisting prompts on-screen to guide users through basic operations.

Users can quickly manipulate objects (points, polygons, lines, text, symbols) and modify objects (insert, move, delete). Flexible routines exist for users to attach a rich amount of attribute data to digitized objects. Symbol creation, reference grids, user-defined object names and attributes, length, area, and centroid calculations are but a few of the many features available.

Picture Composition and Document Preparation

Picture Composition allows the user to create simple or complex illustrations without being a programming expert. The Document Preparation Software is a powerful text formatting package, especially useful for creating and editing large, technical documents. Together, Picture Composition and Document Preparation provide unusual power for creating technical documents, including composition and graphics.

Statistics

The Tektronix statistics library contains the very latest and the traditional methods employed for Tests and Distributions, Analysis of Variance, Multiple Regressions, and Nonlinear Estimations. This well-rounded portfolio includes a special user interface and exploratory graphs to aid in faster analysis and understanding. The Statistics Software in available in separate volumes or at discount as a Library.

Technical Data Representation

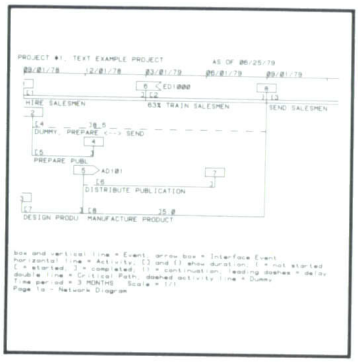
To assist managers in creating presentation quality graphs, a number of various software packages are available. Easy Graphing provides simple methods of constructing line, pie, and bar charts. Presentation Aids assists users in creating management style graphs directly on overhead projector film (included with the software package).

At the heart of the software library is Tektronix graphics; more kinds of interactive graphics and more meaningful graphics than any competitive software on the market. Access to information is of little value if the keys to understanding and communicating are not there, too. PLOT 50 supports the unequalled graphics capability of the 4050 Series.

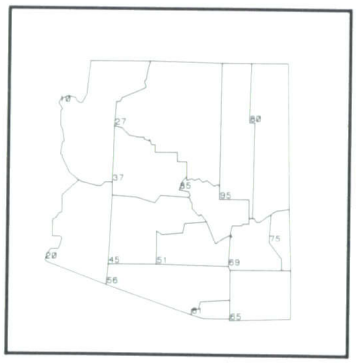
The displays are not only sharper — they're more complete, too, with features like automatically labeled data points. Or the capability to easily transform the same data into different kinds of graphs.

ORDERING INFORMATION

4050A01	Statistics Vol 1 (tape)	$250
4050A02	Statistics Vol 2 (tape)	$250
4050A03	Statistics Vol 3 (tape)	$250
4050A04	Math Vol 1	$250
4050A05	Math Vol 2	$250
4050A06	Electrical Engr	$250
4050A07	Graph Plot	$250
4050A08	General Utilities	$250
4050A09	Business Planning Analysis Vol 1	$800
4050A10	Statistics Vol 4 (tape)	$250
4050A11	Business Planning Analysis Vol 2 (tape)	$995
4050A12	Business Planning Analysis Vol 2 (disk)	$995
4050A13	Statistics Library (tape)	$750
4050A14	Math Library	$400
4050A15	Scientific Library	$1,000
4050A16	Presentations Aids Vol 1	$900
4050A17	MicroPert 2 - Project Management (tape)	$1,000
4050B01	Modeling and Reporting System	$2,400
4050D01	Easy Graphing	$310
4050D02	Statistics: Tests & Distributions (disk)	$300
4050D03	Statistics: Analysis of Variance (disk)	$300
4050D04	Statistics: Multiple Linear Repressions (disk)	$300
4050D05	Statistics: Nonlinear Estimations (disk)	$300
4054D06	Picture Composition	$500
4052D07	Interactive Digitizing	$400
4054D08	2-D Drafting (software only)	$4,000
4052D10	Document Preparation	$300
4050D11	MicroPert 2 - Project Management (disk)	$1,000
4050D13	Statistics Library (disk)	$900
4054D15	2-Drafting System	$29,950



Project Management



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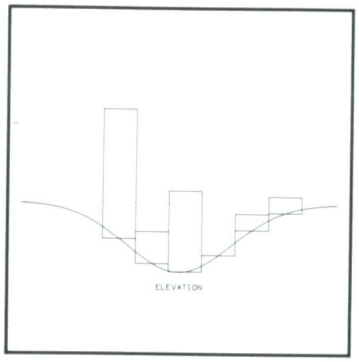
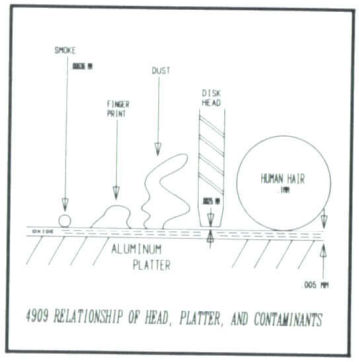


Statistics



4909 RELATIONSHIP OF HEAD, PLATTER, AND CONTAMINANTS

Picture Composition

PLOT 50 2-D Drafting

PLOT 50 2-D Drafting is a state-of-the art automated drafting system providing significant productivity gains in creating and maintaining engineering drawings. Two-Dimensional (2-D) Drafting is designed to comply with current U.S. and International standards and takes advantage of the optional Color Enhanced Dynamic Graphics to present the best in Desktop Drafting.

INTERACTIVITY IS KEY

Only Tektronix offers the 4054A Desktop Computer with a 19-inch high-resolution screen and Color Enhanced Dynamic Graphics for easy viewing. With dynamic graphics, the user can move text and symbols anywhere in the drawing in realtime. 2-D Drafting prompts casual users and incorporates many defaults to speed productivity for more frequent users. Concise, easy to understand messages appear on-screen to prompt you and to display selectable options within functions.

The Tektronix 4054A Desktop Computer has a proprietary display capability to provide unmatched line resolution for creating quality drawings and is one of the highest performance desktop computers available.

2-D Drafting is built around the dynamic graphics capability of the 4054A so you can profit from both stored and refresh images. Messages, the cursor and symbols are displayed as refresh images and the cursor, text and symbols can be moved in realtime.

Users need not be skilled in computer programming to use the power of this software package. The basic procedure is to select a function from the tablet menu and respond to simple prompts and questions relative to that function.

2-D Drafting includes a rich feature set for a broad range of drawing tasks. Your drawings can be in either **English** or **Metric** units and sizes. U.S. and International standards, including ANSI Y-14, have been incorporated. A user-definable snap-to **Grid** and **Cursor** is available. Five **Dash Types** are available: solid, short dash, long dash, center line and phantom. You can choose from up to eight **Plotter Pens.** Multiple methods of entering geometry are included.

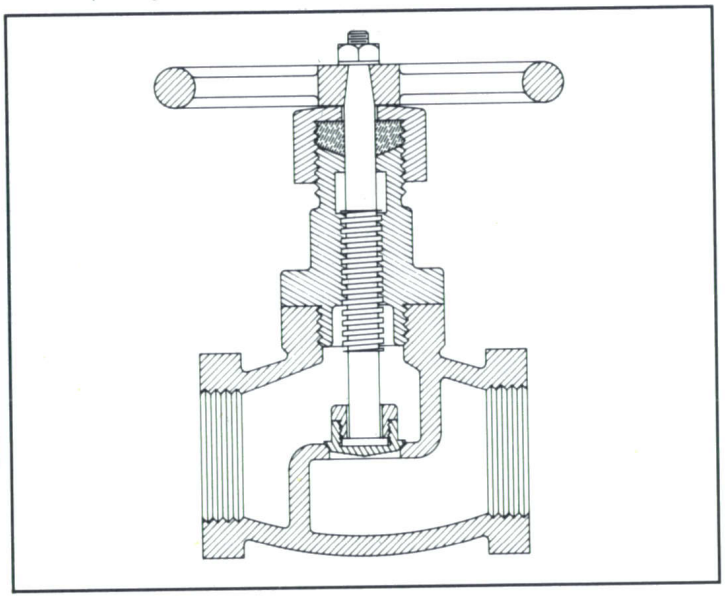
Following Autoload, the system displays a master menu listing five major options: the Tutorial, Draft Mode, Plot Utilities, File Utilities, and End Session.

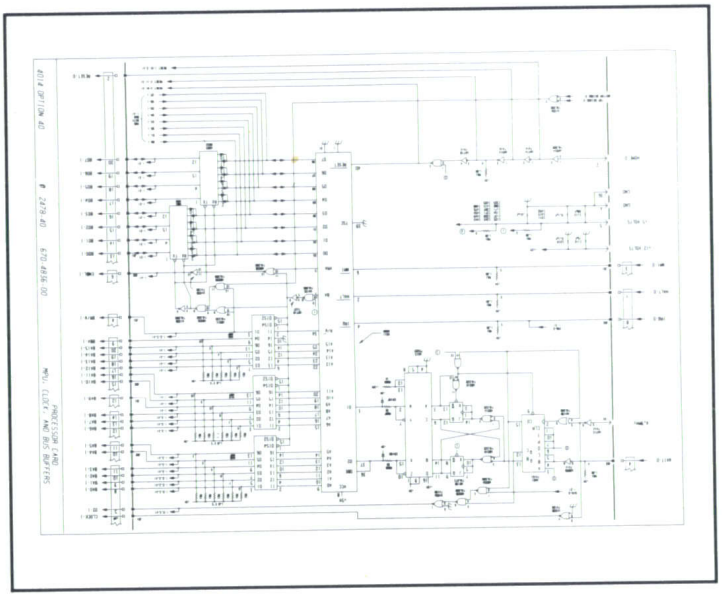
The **Tutorial** presents over 90 pages of information on the major functions in the package and how to use them. **Draft Mode** is the major portion of the software in which drawing creation and editing occur. The **Plot Utilities** allow you to plot any portion of your drawing on Tektronix or other selected plotters. The **File Utilities** provide general operations including renaming files and archiving your work.

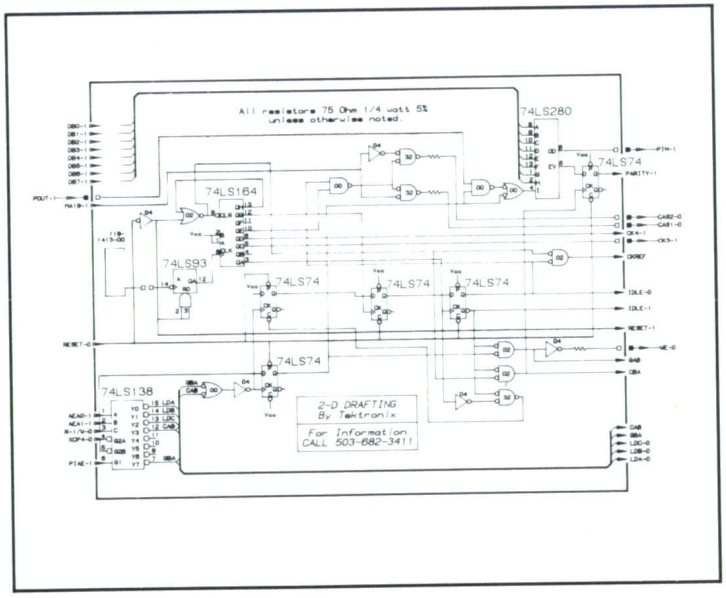
In addition to the Tutorial, **Help** functions have been incorporated directly into the package, and the software is supported by extensive reference materials in the 2-D Drafting User Manual.

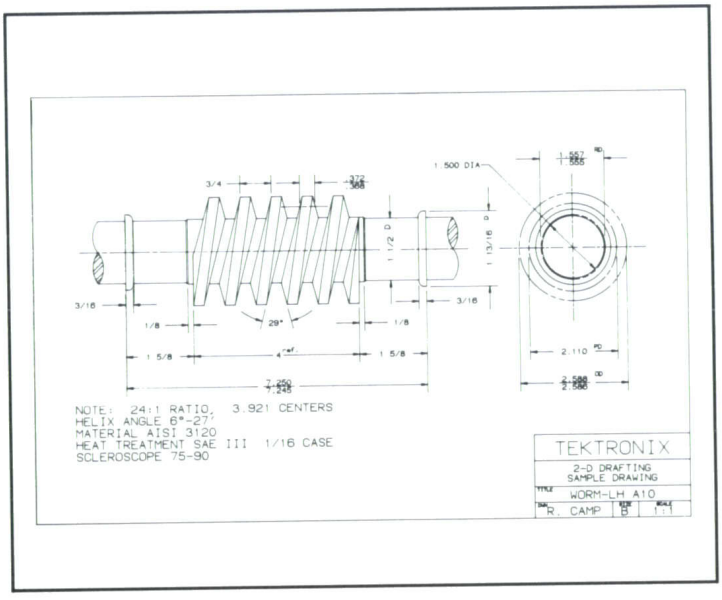
Single-user and multi-user systems are available.

Order 4054D08 PLOT 50 2-D Drafting **$4,000**

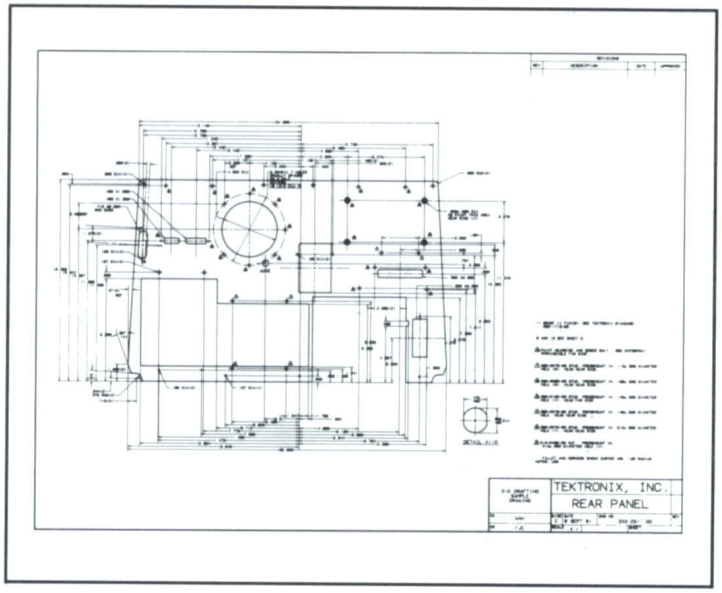


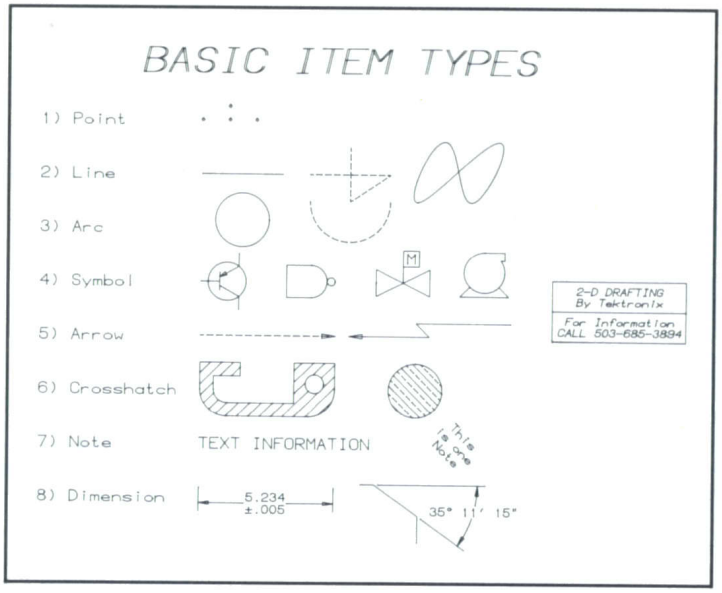


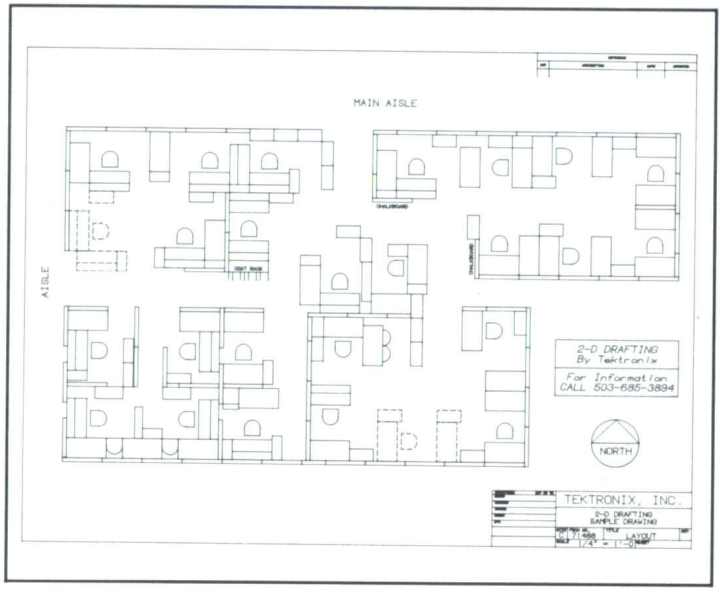


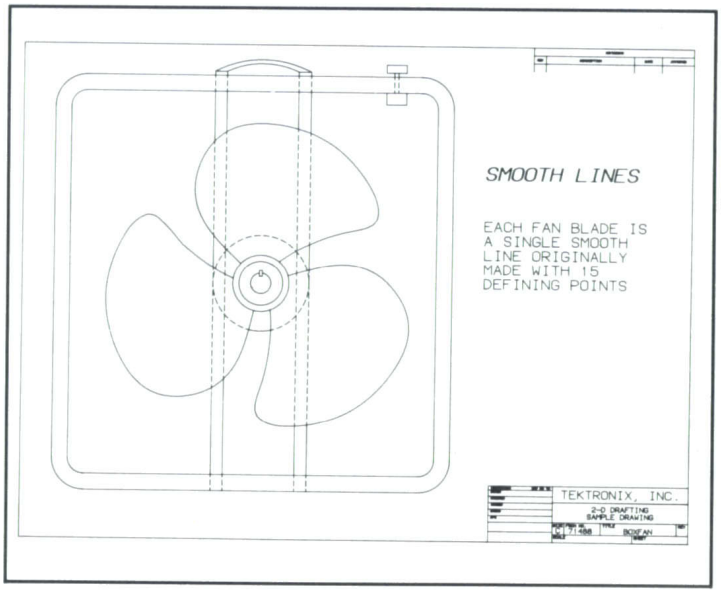


PLOT 50 2-D DRAFTING



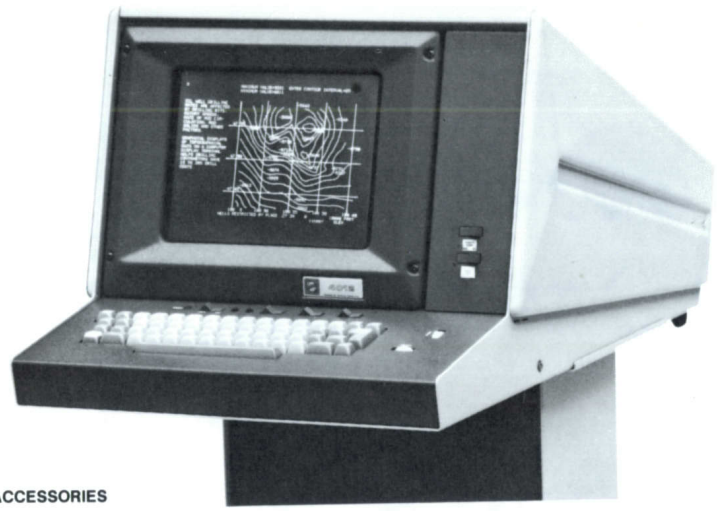






4006-1

4012



4006-1 Computer Display Terminal

Low Cost

Flicker-Free High Resolution

Graphic and Alphanumerics

The 4006-1 Computer Display Terminal makes interactive, high-resolution flicker-free graphics affordable to cost-conscious disciplines and departments. Priced competitively with many alphanumeric (only) terminals, the 4006-1 makes graphic capability practical for the stock room, the classroom and the conference room as well as for other graphic applications.

The 4006-1 connects readily to most mainframes, thanks to its RS-232C interface. A screen capacity of 2590 alphanumeric characters, in addition to its graphics capability, allows the 4006-1 to operate in association with existing alphanumeric terminals to interpret statistical data and transform it into meaningful charts, tables, graphs and diagrams.

The 4006-1 is shipped with a Standard Data Communication Interface conforming to EIA RS-232C, asynchronous full duplex only. Option 01 is a full- or half-duplex interface.

PLOT 10 Software packages designed to be used with the 4006-1 Computer Display Terminal include: Terminal Control System, Advanced Graphing II, Easy Graphing, Interactive Graphics Library, Preview Routines for CalComp Plotters, Minicomputer Software, Character Generation System, and the Interactive Graphing Package.

CHARACTERISTICS

DISPLAY

Medium — Direct view bistable storage CRT.

Dimensions — 190 mm x 142 mm (7.5 in x 5.6 in).

ALPHANUMERIC MODE

Format — 35 lines; 74 character/line; 2590 characters full screen.

Character Set — 63 characters (TTY ANSI Code).

Character Generation — 5 x 7 dot matrix.

Cursor — 8 x 8 dot matrix.

GRAPHICS MODE (VECTORS ONLY)

Vector Drawing Time — 3.6 ms ± 0.2 ms.

Graphics Matrix — 1024 X x 1024 Y addressable points; 1024 X x 780 Y viewable points.

Baud Rate (Transmit and Receive) — 75 baud to 4800 baud.

INCLUDED ACCESSORIES

User's Manual

ORDERING INFORMATION

4006-1 Computer Display Terminal **$3,900**

Option 01 — Optional Data Communications Interface +**$385**

INTERNATIONAL POWER CORD AND PLUG OPTIONS (4006-1 & 4012)

Option A1 — Universal Euro, 220 V/16 A, 50 Hz

Option A2 — UK, 240 V/13 A, 50 Hz.

Option A3 — Australian, 240 V/10 A, 50 Hz

Option A4 — North American, 240 V/15 A, 60 Hz

***WARRANTY PLUS* SERVICE PLAN—REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... +**$385**

OPTIONAL ACCESSORIES

Service Manual

Viewing Hood — Order 016-0346-00 ..... **$12**

Pedestal Kit — Order 016-0364-00 ..... **$320**

4012 Computer Display Terminal

High Resolution, Flicker-Free Graphics

Full Upper and Lower Case ASCII Character Set

Conventional Bus Structure for Peripheral Add-On

The 4012 Computer Display Terminal combines the world's leading graphics with complete alphanumerics. Alphanumerics can tabulate computer data, but graphics can amplify that data into usable, immediately meaningful information. High-resolution graphic presentations and the full ASCII alphanumerics, upper and lower case, are available.

The flicker-free screen provides up to 1024 X x 780 Y displayed graphic points or as many as 2590 alphanumeric characters per display. The TTY-style keyboard simplifies input while the thumbwheel controlled crosshair cursor enhances graphic interactivity. Using thumbwheel control, the operator can direct the X-Y cursor to make additions or deletions of data on the display screen.

PLOT 10 Software packages designed to be used with the 4012 Computer Display Terminal include: Terminal Control System, Advanced Graphing II, Preview Routines for CalComp Plotters, Minicomputer Software, Character Generation System, APL Graph II, the Interactive Graphing Package, Easy Graphing, and the new IGL (Interactive Graphic Library).

Basic Data Communication Interface included with the 4012 is EIA RS-232C compatible (full duplex only). The Optional Data Communication Interface (EIA RS-232A or C) includes convenient switch-selectable functions, independent transmit and receive baud rates, and full- and half-duplex operation.

CHARACTERISTICS

DISPLAY

Medium — Direct view bistable storage CRT.

Dimensions — 203 mm x 152 mm (8 in x 6 in).

ALPHANUMERIC MODE

Format — 74 characters/line; 35 lines/display; 2590 characters/display.

Alphanumeric Cursor — Pulsating 7 x 9 dot matrix.

Character Set — 94 characters (Full ASCII).

Character Size — 85 x 105 mils.

Character Generation — 7 x 9 dot matrix (with MOS ROM.)

Character Generation Rate — 1,000 characters/s.

GRAPHIC MODE (VECTORS ONLY)

Vector Drawing Time — 2.6 ms.

Graphic Matrix — 1024 X x 1024 Y addressable points; 1024 X x 780 Y viewable points.

Cursor — Thumbwheel controlled cross-hair Graphics Matrix; 3 X through 1023 X; 0 Y through 780 Y.

INCLUDED ACCESSORIES

Data Communications Interface RS-232 (021-0065-00); Data Communications Interface Instruction Manual; Users Manual.

ORDERING INFORMATION

4012 Computer Display Terminal **$6,200**

Option 01 — Optional Data Communications Interface +**$525**

Option 02 — DEC PDP-11 W/KL-115 Controller ..... +**$525**

Option 04 — Data General NOVA Interface ..... +**$525**

Option 06 — HP 2100-Series (HP 12531 Card) Interface ..... +**$525**

Option 16 — DEC PDP-11 W/DL-11 Controller ..... +**$525**

Option 30 — Minibus Extender ..... +**$135**

Option 36 — Dual Interface Capability ..... +**$1,120**

***WARRANTY PLUS* SERVICE PLAN—REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... +**$425**

OEM terms are available on these products.

4014-1 Computer Display Terminal

483 mm (19 in) Direct-View Storage Display

Selectable Formats in Alphanumeric and Graphic Modes

High Resolution, Interactive Graphics Capability

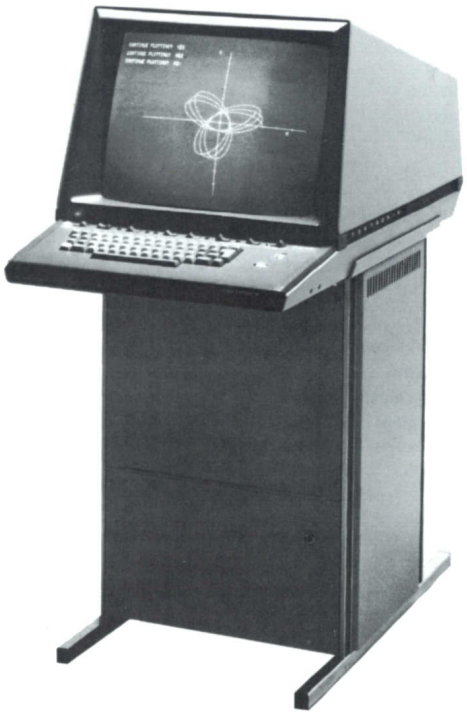
Plug-In Intelligence Options

The most effective way to display a large data base is high resolution, big screen graphics. The 19-inch, flicker-free 4014-1 Computer Display Terminal offers a multitude of capabilities for mapping, design, manufacturing, medicine, energy exploration and many other diverse applications.

The 4014-1 offers 4096 X x 3120 Y displayable points with the standard Enhanced Graphics Module. Its 12 million point capability is more than sufficient to solve most complex mapping and design tasks. Full 94-character ASCII includes four program-selectable alphanumeric formats that display up to 8512 characters at once.

Firmware options provide up to 26 k of graphics memory for local symbols, stroke-drawn characters, overlays, or background graphics, all of which can be redisplayed on command from the host or keyboard. Reduce data transmission as you redraw portions of your graphics from local memory. Circles and arcs are generated by a single command. Add local scaling, rotation, and clipping of graphics. Buffer communications between the host and keyboard. Reduce CPU connect-time through local control of graphic tablets, plotters, and tape and disk storage. A variety of optional intelligence is available to help you keep up with new methods in mapping, process layout, financial graphing and much more.

Tektronix PLOT 10, a versatile modular software product, provides a library of proven graphics packages for all levels of users. PLOT 10 Software includes: IGL (Interactive Graphics Library), a system of I/O device drives, primary commands and advanced feature support for device independent applications: TCS (Terminal Control System) for linking to existing applications, PLOT 10 Easy Graphing II for rapid generation business or scientific graphs and much more.



Interactive previewing on the 4014-1 can considerably reduce time involvement in plotter trial-and-error graphic development. As a cartographer's tool, for instance, the 4014-1 will draw precise maps of cities states, and land formations, and isolate and enlarge those areas you choose.

CHARACTERISTICS

DISPLAY

Medium — Direct view bistable storage CRT.

Dimensions — 483 mm (19 in) diagonal.

Display Area — 381 x 279 mm (15 x 11 in).

ALPHANUMERIC MODE

Character Set — Full ASCII (94 printing characters).

Character Formats — Four, program-selectable
74 char/line by 35 lines;
81 char/line by 38 lines;
121 char/line by 58 lines;
133 char/line by 64 lines.

Alphanumeric Cursor — 7 x 9 dot pulsating.

KEYBOARD

Normal Keyboard — Typewriter paired upper and lower case with auto repeating keys.

GRAPHICS MODE

Vector Drawing Time — 127 m/s (5,000 in/s).

Addressable Points — 4096 X x 4096 Y (12 bits).

Viewable Points — 4096 X x 3120 Y.

INTERACTIVE GRAPHIC MODE

Addressable Points — 3 X through 1024 X; 0 Y through 780 Y.

Crosshair Cursor — Thumbwheel controlled.

COMPUTER INTERFACES

Basic Data Communication Interface — EIA RS-232C compatible, full duplex.

AC POWER

Line Voltage — 110 V ac or 220 V ac (high, med, low).

Line Frequency — 48 Hz to 440 Hz.

Power — 350 W.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	508	20.0
Height	1105	43.5
Depth	825	32.5
Weight	**kg**	**lb**
Net	68.0	150.0

INCLUDED ACCESSORIES

Data Communications Interface (021-0065-00); Data Communications Interface Instruction Manual; User's Manual.

ORDERING INFORMATION

4014-1 Computer Display Terminal ... **$15,750**

Option 01 — Optional Data Communications Interface ..... **+$525**

Option 02 — DEC PDP-11 w/KL-11 Teletype Control Interface ..... **+$525**

Option 04 — Data General NOVA Interface ..... **+$525**

Option 05 — Peripheral Control Inerface ..... **+$790**

Option 06 — HP 2100 Series (HP 12531 Card) Interface ..... **+$525**

Option 16 — DEC PDP-11, -11/05 w/DL-11 Control (M7800) Interface ..... **+$525**

Option 17 — DEC PDP-8/E (M8650 Card) Interface ..... **+$525**

Option 23 — Correspondence Code Interface +2 k Output Buffer ..... **+$1,325**

Option 27 — Additional 32 k of Graphics Memory (Option 40) ..... **+$200**

Option 31 — Display Multiplexer ..... **+$640**

Option 36 — Dual Interface Capability ..... **+$1,120**

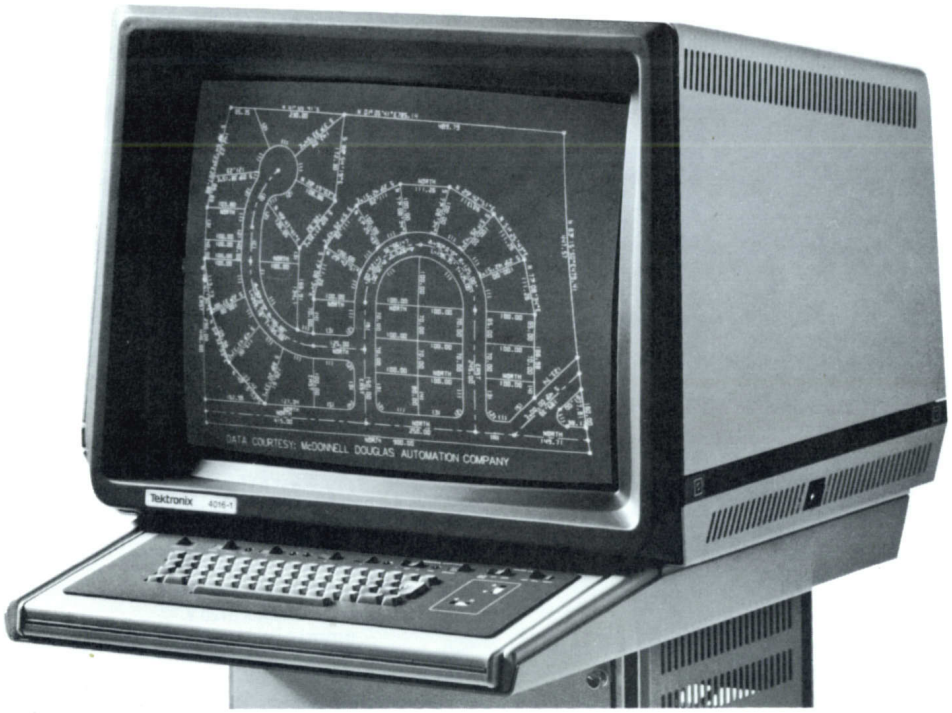
Option 40 — Programmable Keyboard (Req. Option 27) ..... **+$1,780**

Option 41 — Expanded Symbol/Character Package ..... **+$155**

Option 48 — 220 V, 50 Hz ..... **NC**

WARRANTY-PLUS **SERVICE PLAN** **REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$770**



4016-1 Computer Display Terminal

636 mm (25 in) Direct View Storage Display

High-Resolution, Flicker-Free Graphics

Selectable Formats in Graphic and Alphanumeric Modes

Plug-In Intelligence Options

The 4016-1 features a high-resolution, 25-inch display screen that allows designers of electronic circuit boards, utility networks, automotive components, schematic diagrams, street maps or similar applications to work with fine detail while maintaining the total picture perspective.

Using a DVST (Direct View Storage Tube) display, 4016-1 graphic lines are sharp, stable and flicker-free, simplifying the study of fine details. Its 4096 X by 3120 Y viewable points and finely etched 10-mil wide vectors are uniquely suited to display highly complex graphics. Thumbwheel-controlled crosshair cursor makes it easy to interactively manipulate the display.

Over 15,000 Displayable Characters

Besides enabling display of more high density graphic information than any other terminal available, the 4016-1 provides high density alphanumerics for applications from graphic labeling to newspaper page layout. Over 15,000 characters may be displayed simultaneously and may be formatted as 179 alphanumeric characters per line, like a line printer, or in two 85 character columns, like an open book.

Three other larger character formats are standard with the 4016-1, the largest of which is suitable for group viewing.

Complete Tektronix 4014-1 Compatibility

The 4016-1 is compatible with 4014-1 application software, communication support, and other Tektronix peripheral devices. The 4016-1 is supported by the family of PLOT 10 Software products.

Plug-in Intelligence

Using the modular 4010 bus structure, add-on low-cost options include up to 26 k of usable graphics display memory, scaling, relative graphics, clipping, circular arc generation, rotation by one degree increments, user definable stroke characters, programmable keyboard, GPIB interfacing to the intelligent 4924 Digital Cartridge Tape Drive, 4907 File Manager, and 4662 and 4663 Interactive Digital Plotters, plus the 4953 or 4954 Graphics Tablet.

Commands also allow a user to digitize data with distance, time, or gradient filtering; edit graphics from a host computer, local 4907, 4924 storage device or Option 40 programmable keys, and implement off-line plotting by accessing data via local storage devices.

Added Enhancements

The 4016-1 includes a convenient detachable keyboard and detachable display.

Other standard enhancements include hardware generated solid, dashed, and dotted lines; point plotting with software controllable point sizes and incremental "relative graphics" plotting.

CHARACTERISTICS

DISPLAY

Medium — Direct view bistable storage CRT.

Written Image — Bright green on green background.

Dimensions — 636 mm (25 in) diagonal.

Display Area — 454 x 340 mm (18 x 13.5 in).

ALPHANUMERIC MODE

Character Set — Full ASCII (94 printing characters).

Standard Character Formats
74 char/line by 35 lines;
81 char/line by 38 lines;
133 char/line by 64 lines;
179 char/line by 86 lines.

Optional Character Formats
74 char/line by 35 lines;
81 char/line by 38 lines;
121 char/line by 58 lines;
133 char/line by 64 lines.

Alphanumeric Cursor — 7 x 9 dot pulsating.

KEYBOARD

Normal Keyboard — Typewriter paired upper and lower case with auto repeating keys.

GRAPHICS MODE

Drawing Time/Resolution Vector Drawing Time — 200 m/s (8,000 in/s).

Addressable Points — 4096 X x 4096 Y (12 bits).

Viewable Points — 4096 X x 3120 Y.

Vector Formats — Five (straight, dotted and dashed lines).

INTERACTIVE GRAPHIC MODE

Addressable Points — 0 X through 1023 X; 0 Y through 780 Y.

Crosshair Cursor — Thumbwheel controlled.

COMPUTER INTERFACES

Basic Data Communications Interface — EIA RS-232C compatible, full duplex.

AC POWER

Line Voltage — 110 V ac or 220 V ac (high, med, low).

Line Frequency — 48 Hz to 66 Hz.

Power — 450 W.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	680	27.0
Height	1278	50.7
Depth	756	30.0
Weight	**kg**	**lb**
Net	113.0	250.0

INCLUDED ACCESSORIES

Data Communications Interface (021-0065-00); wheel kit (040-0714-00); Data Communications Interface instruction manual; user's manual.

ORDERING INFORMATION

4016-1 Computer Display Terminal ... **$20,500**

Option 01 — Optional Data Communications Interface **+$525**
Option 02 — DEC PDP-11 w/KL-11 Control Interface . **+$525**
Option 04 — Data General NOVA Interface ..... **+$525**
Option 05 — Peripheral Control Interface ..... **+$790**
Option 06 — HP 2100 Series (HP 1231 Card) Interface ..... **+$525**
Option 16 — DEC PDP-11, -11/05 Control (M7800) Interface ..... **+$525**
Option 17 — DEC PDP 8/E (M8650 Card) Interface .. **+$525**
Option 23 — Corres Code Interface + 2 k Output Buffer ..... **+$1,325**
Option 27 — Additional 32 k of Graphics Memory (Option 40) ..... **+$200**
Option 31 — Display Multiplexer ..... **+$640**
Option 32 — 4014 Character Set ..... **NC**
Option 35 — Dual Interface Capability ..... **+$935**
Option 40 — Programmable Keyboard (Req. Option 27) ..... **+$1,780**
Option 41 — Expanded Symbol/Character Package . **+$155**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz

WARRANTY-PLUS **SERVICE PLAN** REFER TO PAGE 41

N1 — Service Plan + 9 Months Service ..... **+$1,030**

OPTIONAL ACCESSORIES

Remote Display Cable Kit — Order 020-0413-00 ..... **$600**
Service Manual
Calibration Graticule (25 in) — Order 067-0877-00 ..... **$650**
Logic Extender Card — Order 067-0653-00 ..... **$750**
Extender, 72 Pin — Order 067-0664-00 ..... **$150**
Blank Vector Board — Order 018-0065-01 ..... **$110**
I/F Cable for Opt 01
Deluxe RS-232 I/F (16 ft) — Order 012-0716-00 ..... **$90**
I/F Cable for Opt 01
Deluxe RS-232 I/F (50 ft) — Order 012-0717-00 ..... **$160**
I/F Cable for Opt 02
TTY Port I/F (16 ft) — Order 012-0293-00 ..... **$145**
I/F Cable for Opt 02
TTY Port I/F (50 ft) — Order 012-0294-00 ..... **$260**
I/F Cable for Opt 16
TTY Port I/F (16 ft) — Order 012-0429-00 ..... **$100**
I/F Cable for Opt 16
TTY Port I/F (50 ft) — Order 012-0429-01 ..... **$295**
Display Multiplexer Cable (20 ft) — Order 012-0662-03 ..... **$150**
(For 018-0067-02 Display Mux Card, Opt 31).

OEM terms available on this product.

4025A

4027A

4025A Computer Display Terminal and 4027A Color Graphics Terminal

From Alphanumerics to Color Graphics

Forms Ruling Option Available

PLOT 10 Compatible

ASCII Character Set and Finger Tip Editing

Fully Supported Color Capability (4027A)

Dynamic Displays Easily Created

The 4025A and 4027A provide a marriage of alphanumerics and graphics. You can create and store multiple graphs in memory, create multiple graphs per page, and scroll graphics along with alphanumeric information. The 4025A is monochrome, the 4027A adds full color. Colors, selected with the Lightness, Saturation and Hue controls, are chosen from a 64 color palette with up to eight colors simultaneously displayed.

Forms mode and ruling can duplicate essentially any form. Visual attributes include 4025A enhanced, blinking, inverted and underlined fields and 4027A color enhancements. Logical attributes include protected fields, alphanumeric unprotected or numeric only.

Local capabilities of the 4027A include colored vectors, characters, symbols, and polygon fill with a second color to border the polygon. User may select up to 120 different patterns or color combinations. These firmware initiated capabilities make minimal demands on host computer communications.

The PLOT 10 Easy Graphing Software package lets you interactively create bar charts with multiple shadings, histograms, log plots, pie charts and period axes, all with a wide variety of labeling options. The 4027A uses color-enchanced PLOT-10 to construct line graphs with special symbols and dashed lines, legends, titles, and grids, and up to six curves or colored bar charts.

For ease of data entry and editing, the display screen can be divided into two separate display areas, each with independent scrolling. Use the monitor area to communicate with the host and the workspace area for the form or graphic display. Hard copy output is standard.

The keyboard is a standard office typewriter configuration. Predefined editing keys simplify insertion, deletion and input of lines and characters. User-definable function keys, plus nearly all other keys on the keyboard, can be redefined to generate a command or character string at the touch of a finger.

A 16 k display memory is standard expandable to 32 k, allowing buffering and scrolling of many pages. Graphic capability of 32 k memory is added to the 4025A with Option 26. The 4027A comes standard with 48 k graphics, and increases to 192 k with Option 29.

Graphic input capability, standard with the 4027A and optional with the 4025A, consists of a key controlled graphic crosshair cursor. Coordinates are reported back to the host; the color of the designated coordinate being reported by the 4027A.

The RGB and video signal output allows connection of the 4027A to external video displays for group viewing and presentations.

CHARACTERISTICS (4025A)

The following characteristics are common to the 4025A and the 4027A, except those noted under the 4027A.

DATA TRANSMISSION

Data Rate — 9600 baud.
Communications Interface — RS-232C, full duplex standard (Option 01 for half and full duplex).

DISPLAY

Medium — Raster scan, 525 standard with 480 displayed and 640 addressable points.
Type — Dot Matrix (each character position has 14 rows of 8 dots each).
Resolution — 26 to 28 addressable points/cm.
Line Types — Dashed, points, solid, PLOT 10 compatible.
CRT Refresh Rate — Dot and Frame: 30/s. Field: 60/s.
Memory — Display: 16 kbytes standard. Graphic: 32 kbytes (optional).
Dimensions — (7 x 9 inch), 12 inch diagonal.
Cursor Types — Alphanumerics: Wide underscore. Graphic: Full screen crosshair (optional).

KEYBOARD

Normal Keyboard — 86 typewriter (4 lighted).
Programmable Keys — 81.
Cursor Position — Key control.
Scrolling — Key control.
Numeric Pad — Key control.
Terminal Functions — Key control.

ALPHANUMERIC MODE

Standard Displayable Character Set — 128 (full ASCII); optional character sets available.
Character/Line — 80.
Line/Display (Rows) — 34.
Characters Full Screen — 2,720.
User-Definable Character Sets — Up to 31 fonts.

AC POWER

Ranges — 90 V ac to 136 V ac, 3 A maximum.
Power Consumption — 48 Hz to 63 Hz, 295 W maximum at 125 V ac.

CHARACTERISTICS (4027A)

The following characteristics are unique to the 4027A, other characteristics are common with the 4025A.

DISPLAY

Medium — Shadow mask.
Memory — Display: 16 kbytes standard. Graphic: 48 kbytes standard, or 192 kbytes (optional).
Dimensions — 191 mm x 254 mm (7.5 x 10 inch), 13 inch diagonal.
Cursor Types — Graphic: Full screen crosshair standard.
Colors — 64 palette, eight displayable at once, 120 user-definable patterns .
Line Types — Dashed, points, solid (one of eight colors with), PLOT 10 compatible.

AC POWER

Ranges — 90 V ac to 132 V ac, 6 A maximum.
Power Consumption — 48 Hz to 63 Hz, 550 W maximum at 125 V ac.

PHYSICAL CHARACTERISTICS

	4025A		4027A	
Dimensions	**mm**	**in**	**mm**	**in**
Width	445	17.5	584	23.0
Height	317	12.5	482	19.0
Depth	540	21.2	584	23.0
Weight	**kg**	**lb**	**kg**	**lb**
Net	27.2	60.0	45.3	100.0

Included and optional accessories available.

ORDERING INFORMATION

4025A Computer Display Terminal **$5,900**
4027A Color Graphics Terminal **$10,900**

Option 01 — Half/Full Duplex Interface ..... **+$160**
Option 02 — Current Loop Interface ..... **+$250**
Option 03 — RS-232C Peripheral Interface*1 ..... **+$330**
Option 04 — GPIB Peripheral Interface*1 ..... **+$440**
Option 4A — United Kingdom Keyboard ..... **NC**
Option 4B — French Keyboard ..... **NC**
Option 4C — Swedish Keyboard ..... **NC**
Option 22 — 32 Kbytes of Display Memory ..... **+$100**
Option 26 — Graphics and 32 Kbytes of Graphics Memory (4025A only) ..... **+$800**
Option 29 — 192 Kbytes of Graphics Memory (4027A only) ..... **+$900**
Option 31 — Character Set Expansion and ROMs .... **+$450**
Option 36 — Peripheral ROM ..... **+$165**
Option 38 — Keyboard Graphic Input Interface*2 ..... **+$400**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro, 220 V/16 A, 50 Hz
Option A2 — UK 240 V13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz

***WARRANTY-PLUS* SERVICE PLAN** **REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service (4025A only) ..... **+$260**

**1 Requires Option 36.*
**2 4025A only — requires Option 26.*

Tektronix offers service training classes on the 4025A and 4027A. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.

NEW

614/616/618

Storage Display Monitors

High Resolution Graphics

Combined Stored and Write Thru Mode

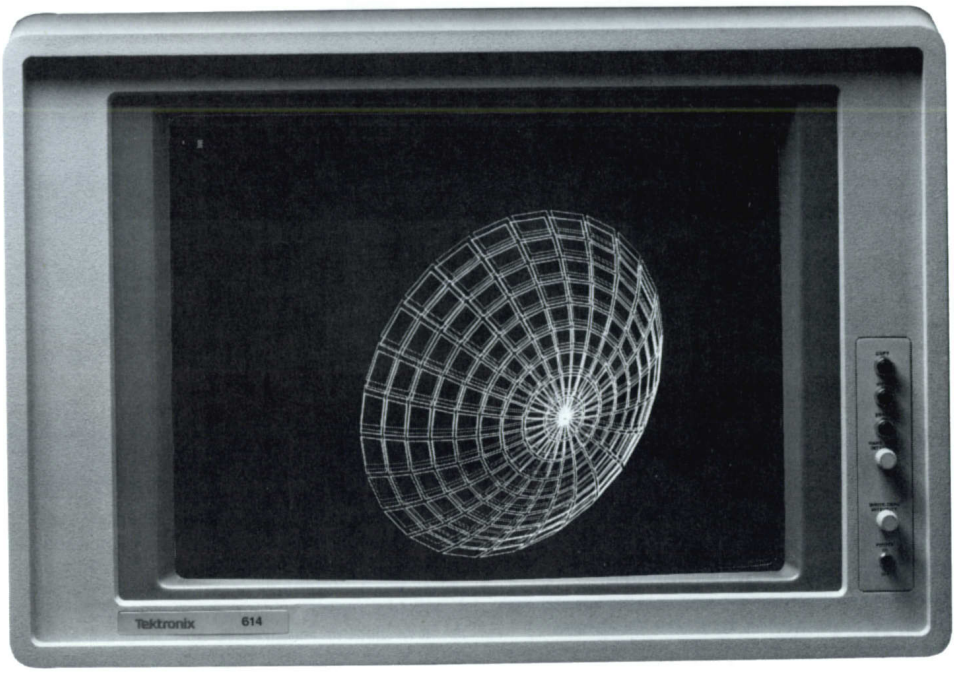
19 and 25 Inch Diagonal CRT

The 614, 616, and 618 are high performance analog input bistable storage display monitors. This family of displays is capable of displaying alphanumerics and high resolution, high density graphics at a low cost. In the storage mode, graphic lines are sharp, stable, and flicker-free making it easy for the user to study the finer details of a design. The write-thru mode (a technique by which refreshed data appears on the screen at the same time as stored graphics), allows increased viewability, selective erase, interactivity, and dynamic motion with the same high resolution. Write-thru color is green on the 616 and 618; and yellow-orange on the 614. This permits rapid differentiation of working and stored information.

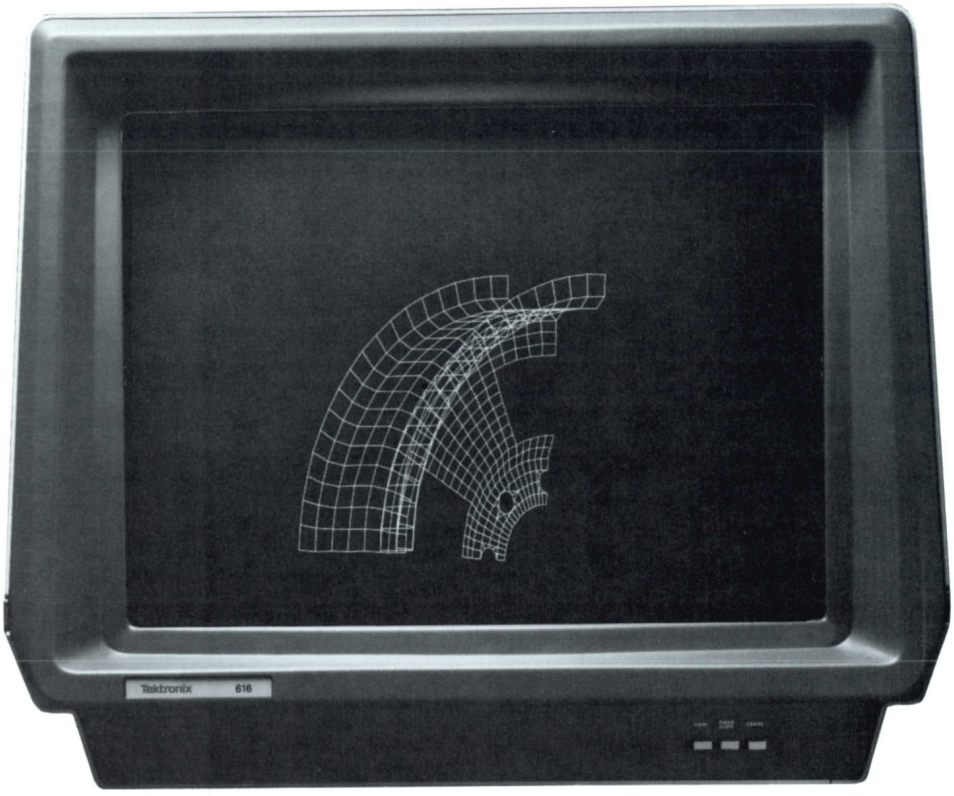
APPLICATIONS

The 614/616/618 family is well suited as a high-speed interactive graphics attachment to the IBM 3277 Model 2 Display Station, enhancing the capabilities of the overall system. The graphics attachment and software (RPQ7H0284 and P09013 from IBM) allows the display monitor to add a wide range of graphics capabilities to the station. A dual display station is thus configured with the IBM monitor displaying the alphanumeric data and the Tektronix storage monitor displaying graphics information and special symbols. The 614, 616 and 618 are versatile displays and can be used in other environments which can benefit from productivity improvements offered by advanced storage display monitors with refresh capabilities.

614

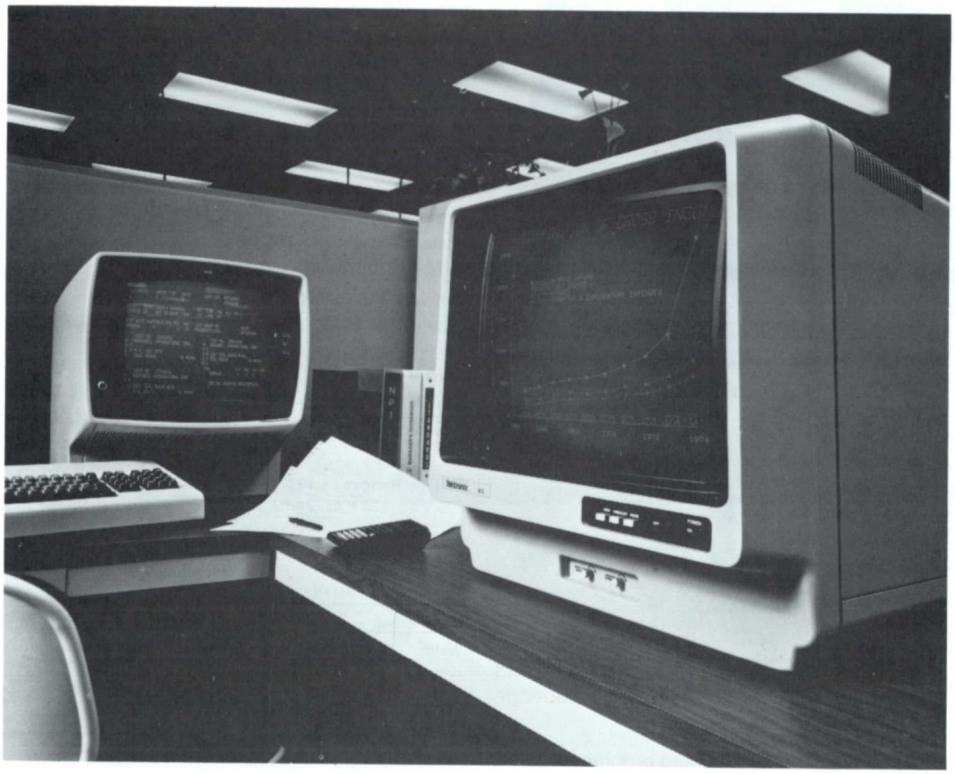


616



STORAGE DISPLAY MONITORS

618



614/616/618 Operations

All display functions are completely programmable and designed to interface to standard TTL level logic. The X and Y deflection amplifiers have differential analog inputs. A CRT antiburn circuit is provided to help protect against burning the CRT phosphor in the event that the beam is moving too slowly across the CRT with the Z-axis turned on or the X and Y deflection fails. If there is no screen activity for approximately two minutes, the screen brightness will be reduced to prolong CRT life. After thirty minutes of inactivity, the screen is automatically erased.

CHARACTERISTICS

The following characteristics are the same for the 614, 616, and 618 unless otherwise noted.

DISPLAY

CRT Type — Direct view storage.

Dimensions — 614/618: 48 cm (19 in) diagonal. 616: 63 cm (25 in) diagonal.

Display Area — 614/618: 26.7 x 35.6 cm (10.5 in x 14 in). 616: 49.0 x 36.2 cm (19.3 in x 14.25 in).

Stored Writing Speed — 614/618: 150 m/s. 616: 200 m/s.

Refresh Writing Speed — 500 m/s. 616: 1500 m/s.

Write-Thru Contrast Ratio — ≥4:1.

Max Z-Axis Repetition Rate — 614/618: 1 MHz. 616: 2 MHz.

Stored Luminance — 614: N/A. 618: 7 cd/m² (5 fl). 616: 13.7 cd/m² (>4 fl).

Resolution — Center Screen: 15.7 lines/cm (40 lines/inch). Screen Edges: 13.8 lines/cm (35 lines/inch).

Positional Accuracy — 614/618: ±1.25% of long axis. 616: ±2.5% of long axis.

Stored Dot Writing Time — 614/618: ≤5 μs. 616: ≤2 μs.

Settling Time (Non linear operation; ≥1 cm deflection) — 614: 3 μs +4 μs/cm to within 1 spot diameter.
616: 1 μs +2 μs/cm to within 1 spot diameter.
618: 5 μs +5 μs/cm to within 1 spot diameter.

Erase Time — 614/618: 1.5 s ±20%. 616: 1.0 s ±12%.

POWER

Line Voltage — 614/618: 100 V ac, 120 V ac, 220 V ac, 240 V ac ±10%. 616: 90 V ac to 132 V ac and 190 V ac to 250 V ac (selectable).

Line Frequency — 48 Hz to 66 Hz. 616: 48 Hz to 440 Hz.

Power at 115 V ac, 60 Hz — 614/618: 220 W max. 616: 350 W max.

PHYSICAL CHARACTERISTICS

Dimensions	614		616		618	
	mm	in	mm	in	mm	in
Width	584	23.0	686	27.0	572	22.5
Height	426	42.6	591	23.3	533	21.0
Depth	582	22.9	565	22.2	647	25.5
Weights	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net	46.0	100.0	68.0	150.0	46.0	100.0
Shipping	55.0	120.0	86.0	190.0	55.0	120.0

INCLUDED ACCESSORIES

Power cord (161-0066-00); instruction manual.

ORDERING INFORMATION

614 Storage Display Monitor **$13,790**
616 Storage Display Monitor **$14,375**
618 Storage Display Monitor **$11,945**

Option 30 — Interconnecting Cable (to Allow Attachment to IBM 3277 Model 2) ..... **+$155**
Option 38 — Blue Glass Filter (616 Only) ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz (N/A on 614)
Option A3 — Australian 240 V/10 A, 60 Hz (N/A on 614)
Option A4 — North American 240 V/15 A, 60 Hz (N/A on 614)

***WARRANTY-PLUS* SERVICE PLAN** REFER TO PAGE 41

N1 — (614/618) Service Plan + 9 Months Service .... **+$600**
N1 — (616) Service Plan + 9 Months Service ..... **+$855**

OEM terms available on this product.

4051 Desktop Computer

GPIB
IEEE-488

The 4051 is designed to support other products that comply with IEEE Standard 488-1978.

Powerful, Easy-to-Use Desktop Computing with Extended BASIC

High Resolution Graphics and Alphanumerics

Desktop computing for a whole spectrum of problem solving, data analysis, and decision making applications. The 4051 is stand-alone computing power that is approachable, affordable, and able to grow as your applications grow. It includes integrated computing peripherals, and a GPIB interface.

Friendly Graphics

Commands like Draw and Rotate built into the 4051 give you full graphics flexibility while working in your units, not machine or raster units.

The magnetic cartridge tape drive is built into the 4051 hardware and language. File management commands like Find, Old, Read, and Write, retrieve or store programs and data. A comfortable typewriter keyboard is integrated into the system with a 36-character buffer that eliminates lost entries.

Extended BASIC language provides both power for the sophisticated programmer and simplicity for the beginner. Input and output can be as simple at Input or Print or can have FORTRAN-like power with Print, Delete and Image commands.

Data Communications Interface (Option 01) permits data exchange with a host computer. Option 01 also enables the 4051 to emulate a terminal with direct host-to-terminal data transfer. Terminal modes provide local intelligence and direct data transfer between the built-in cartridge tape drive and host computer.

The GPIB is built-in and easy to program with the 4051 BASIC I/O commands. As the industry's choice for connecting instrumentation it is our choice for the 4051 and its many available peripherals.

ROM Packs

A variety of Read Only Memory (ROM) Packs are available to perform utility functions. The Editor ROM allows general editing of data files (including BASIC, FORTRAN or COBOL programs). The Signal Processing ROM's provide common functions such as integration, minimum/maximum functions and FFT. The GPIB Enhancement ROM improves the 4050 Series as an instrument controller. The 4051R12 substantially increases the graphics capabilities of the 4051.

CHARACTERISTICS

DATA TRANSMISSION

Data Communications Interface (Option 01) — Full or half duplex.

Data Type — Asynchronous.

Data Rate — Up to 2400 baud.

Printer Interface (Option 10) — EIA RS-232 and RS-244A compatible up to 2400 baud.

GPIB Conformance — IEEE Standard 488-1978 (byte serial, bit parallel).

DISPLAY

CRT Type — Direct view storage.

Graphic Resolution — 1024 x 780 displayable points.

Dimensions — 192 mm x 162 mm (7.5 x 5.5 in).

Character Set — Full ASCII upper/lower case. (Also includes Scandinavian, German, Central European, Spanish, special graphic symbols.)

Character Format — 72 character/line, 35 lines.

KEYBOARD

Normal Keyboard — 128 upper and lower case (full ASCII) with auto repeat.

User Definable Function Keys — Ten-shiftable to 20. Keys for single-step program execution, auto numbering, rewinding tape, autoload/execute first program.

Calculator Key Pad — Five math functions.

Numeric Keys — Ten.

CENTRAL PROCESSING UNIT

Type — LSI 8-bit microprocessor.

Standard Memory Workspace — 16 kbytes (32 k with Option 22).

Programming Language — BASIC with extensions.

Dynamic Range — $\pm 10^{-308}$ to $\pm 10^{308}$.

Numeric Accuracy — 14 decimal digits (12 displayed).

TAPE DRIVE

Cartridge — Magnetic.

Type — 300A, 300XL, and 600A Certified Data Cartridges from Tektronix.

Rewind Speed — 90 ips.

Search/Read Speed — 30 ips.

Structure — 256 bytes w/header.

AC POWER

Voltage Ranges (±10%) — 100 V ac, 110 V ac, 120 V ac; or 200 V ac, 220 V ac, 240 V ac.

Line Frequency — 48 Hz to 66 Hz.

Power — 200 W max.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	465	18.3
Height	345	13.6
Depth	826	32.5
Weight	**kg**	**lb**
Net	29.5	65.0

Operating Temperature — +10°C to +40°C.

INCLUDED ACCESSORIES

System software tape (020-0160-04); system software back-up tape (020-0161-04); power cord (161-0066-00);pkg of 10 blank user definable key overlays (334-2630-02); 4050 series graphic system operator's manual; 4050 series graphic system reference manual; introduction to programming in basic manual; introduction to graphic programming in basic manual.

Note: A full line of optional accessories are available.

ORDERING INFORMATION

4051 Desktop Computer **$4,995**
Option 01 — Data Communications Interface ..... **+$500**
Option 10 — Printer Interface ..... **+$300**
Option 22 — 32 Kbytes Total Memory ..... **+$150**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz.
Option A2 — UK 240 V/13 A, 50 Hz.
Option A3 — Australian 240 V/10 A, 50 Hz.
Option A4 — North American 240 V/15 A, 60 Hz.
Option A5 — Switzerland 220 V/10 A, 50 Hz.

***WARRANTY-PLUS* SERVICE PLAN** REFER TO PAGE 41

N1 — Service Plan + 9 Months Service ..... **+$685**

ROM PACKS FOR THE 4051

4051R06 Editor ROM Pack **$200**
4051R07 Signal Processing ROM Pack #1 ..... **$200**
4051R08 Signal Processing ROM Pack #2 ..... **$300**
4051R10 Advanced File Manager ROM Pack (for 4909) **$300**
4051R12 Graphics Enhancement ROM Pack **$495**
4051R14 GPIB Enhancement ROM Pack **$495**

Tektronix offers users training classes on the 4050 Series Desktop Computers. For further information, contact the Customer Training Registrar at (503) 685-3808 or your nearest Tektronix Sales Office.

OEM terms are available on this product.

GPIB IEEE-488 4052A Desktop Computer

The 4052A is designed to support other products that comply with IEEE Standard 488-1978.

Fast Processing

High Level BASIC

Extended Memory File Manager (Option)

The 4052A Desktop Computer provides computation and communications for a whole spectrum of problem solving, data analysis, and decision making applications. It offers high performance stand-alone computing power, flexible data communications, and easy-to-learn, extended BASIC. These features, combined with high resolution graphics, make the 4052A an excellent choice for scientific and statistical research, forecasting, data acquisition, and analysis.

For rapid calculation, the 4052A has a fast processor with microcode floating point. Fast processing coupled with simultaneous display of text and graphics meets the needs of most application requirements.

A magnetic cartridge tape drive is built-in, allowing both ASCII and binary programs or data to be easily stored and retrieved using simple file management commands in BASIC.

An optional extended memory file manager allows very high speed access to an additional 256 k or 512 k memory. The file manager permits heavily used programs and data files to be read, updated, and written very quickly.

New extended BASIC provides the simplicity desired by the beginner and the flexibility and power required by the experienced programmer. Device independent keywords such as Input and Print make programming input and output operations easy. Fast matrix functions such as multiply, inverse, transpose, identity and determinants are built into BASIC.

Friendly Graphics

Commands like Move, Draw and Rotate in BASIC allow graphic displays to be created on the 4052A using user defined units, not machine or raster units.

ROM Packs

A variety of Read Only Memory (ROM) Packs are available to perform utility functions. The Editor ROM allows general editing of data files (including BASIC, FORTRAN or COBOL programs). The Signal Processing ROM's provide common functions such as integration, minimum/maximum functions and FFT. The GPIB Enhancement ROM improves the 4050 Series as an instrument controller. The 4052R12 substantially increases the graphics capabilities of the 4052A.

CHARACTERISTICS

DATA TRANSMISSION

Data Type — Asynchronous.
Data Rate — Up to 9600 baud.
Data Communications Interface (Option 01) — Full or half duplex.
Printer Interface (Option 10) — EIA RS-232 or RS-244A compatible.
GPIB Conformance — IEEE Standard 488-1978 (byte serial, bit parallel).

DISPLAY

CRT Type — Direct view storage.
Dimensions — 192 mm x 141 mm (7.5 in x 5.5 in) 282 mm (11 in) diagonal.
Graphic Resolution — 1024 x 780 viewable points; 1024 x 1024 addressable points.
Character Set — Full ASCII (German, Swedish, Danish/Norwegian, British, Spanish, Graphic and Business font selectable under program control).
Character Format — 72 character/line, 35 lines.

KEYBOARD

Normal Keyboard — 128 ASCII, upper/lower case (full ASCII) with auto repeat.
User Definable Function Keys — Ten-shiftable to 20. Keys for single-step program execution auto-numbering, rewinding tape, autoload/execute first program.
Calculator Key Pad — Five math functions.
Numeric Keys — Ten.

CENTRAL PROCESSING UNIT

Type — LSI, bipolar, 16 bit.
Standard Memory Workspace — 32 kbytes total (64 k with Option 24).
Programming Language — High level BASIC with extensions.
Dynamic Range — $\pm 10^{-308}$ to $\pm 10^{308}$.
Numeric Accuracy — 14 decimal digits (12 displayed).

TAPE DRIVE

Cartridge — Magnetic.
Type — 300A, 300XL, and 600A Certified Data Cartridge from Tektronix. 300 k, 450 k, or 600 kbytes.
Rewind Speed — 90 ips.
Search/Read Speed — 30 ips.
Structure — 256 bytes w/header.

AC POWER

Voltage Ranges (±10%) — 100 V ac, 110 V ac, 120 V ac or 200 V ac, 220 V ac, 240 V ac.
Line Frequency — 48 Hz to 66 Hz.
Power — 300 W maximum.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	465	18.3
Height	345	13.6
Depth	826	32.5
Weight	**kg**	**lb**
Net	30.8	68.0

Operating Temperature — +10°C to +40°C.

INCLUDED ACCESSORIES

System software tape (020-0160-04); system software back-up tape (020-0161-04); power cord (161-0066-00); pkg of 10 blank user definable key overlays (334-2630-02); basic and GPIB enhancements reference; 4050 series graphic system operator's manual; 4050 series graphic system reference manual; introduction to programming in basic manual; introduction to graphic programming in basic manual; firmware instructions version 5.1/1.3 manual; reference guide to 4050 series basic.
Note: A full line of optional accessories are available.

ORDERING INFORMATION

4052A Desktop Computer **$9,900**
Option 01 — Data Communications Interface ..... +$600
Option 02 — Four Slot ROM Backpack ..... +$400
Option 03 — Four Slot Data Communications Interface ..... +$900
Option 10 — RS-232 Printer Interface ..... +$550
Option 24 — 64 Kbytes Total Memory ..... +$290
Option 27 — 256 Kbytes Extended Memory File Manager ..... +$2,400
Option 28 — 512 Kbytes Extended Memory File Manager ..... +$3,200

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN** **REFER TO PAGE 41**
N1 — Service Plan + 9 Months Service ..... +$770

ROM PACKS FOR THE 4052A/4054A

4052R06 Editor ROM Pack **$495**
4052R07 Signal Processing ROM Pack #1 ..... **$250**
4052R08 Signal Processing ROM Pack #2 ..... **$495**
4052R09 Real-Time Clock ROM Pack **$495**
4052R10 Advanced File Manager ROM Pack (for 4909) **$400**
4052R11 Character and Symbol ROM Pack **$495**
4052R12 Graphics Enhancement ROM Pack **$495**
4052R14 GPIB Enhancement ROM Pack **$495**

Tektronix offers user training classes on the 4050 Series desktop computer. For further information, contact the Customer Training Registrar at (503) 685-3808 or your nearest Tektronix Sales Office.

GPIB IEEE-488 4054A Desktop Computer

The 4054A is designed to support other products that comply with IEEE Standard 488-1978.

19 Inch, High Resolution Display

Dynamic Graphics (Option 30)

Extended Memory File Manager (Option)

Color Enhanced Graphics (Option 31)

Unequalled graphics and powerful, fast computations, the 4054A is the only integrated desktop computer that combines easy-to-learn, extended BASIC with the unique features of a large-screen, high resolution display. For rapid calculation, the 4054A has a fast processor with microcoded floating point.

The 4054A has a long list of proven peripheral products. GPIB (General Purpose Interface Bus) and RS-232C interfacing coupled with easy-to-program BASIC I/O commands allow considerable versatility in designing your own system.

An optional extended memory file manager allows very high speed access to an additional 256 k or 512 k memory. The file manager permits heavily used programs and data files to be read, updated and written very quickly.

The 4054A features software compatibility with the rest of the 4050 Series of desktop computers. Programs developed on the 4051 and 4052A will operate on the 4054A, giving its users access to a wealth of PLOT 50 Software, already written and debugged, thus reducing program development costs often associated with new systems.

The Dynamic Graphics (Option 30) adds increased interactivity to the graphics of the 4054A and brings the user closer to the solution by providing the graphic power to work directly with the graphic elements of the design problem. Complicated displays can be constructed quickly and easily with movable user-defined objects.

Superior Graphic and Alphanumeric Display

With 4096 X and 3120 Y resolution (12 million displayable points,) the 4054A has all the graphics capability you will need for even the most complex display. With stroke-generated characters programmable in four sizes and eight fonts, the 4054A has the tools to alphanumerically dress up your output to suit any professional requirement. The large screen permits previewing of 132 column line printer output.

For your graphing needs there are 36 distinct dot-dash patterns, selectable under program control, providing for maximum effect of represented data. For interaction the 4054A has a thumbwheel driven, true crosshair cursor. All of these features are implemented using the extended BASIC of the 4054A.

New powerful extended BASIC provides the simplicity desired for the beginner together with the flexibility and power required by the experienced programmer. Device independent keywords make program and data input/output operations easy. Fast, built-in BASIC functions such as SINE, LOG, SQR, etc., plus a complete set of matrix functions provide powerful computation at your fingertips.

CHARACTERISTICS

DATA TRANSMISSION

Data Communications Interface (Option 01) — Full or half duplex.
Data Type — Asynchronous.
Data Rate — Up to 9600 baud.
Printer Interface (Option 10) — EIA RS-232 or RS-244 Compatible up to 9600 baud.
GPIB Conformance — IEEE Standard 488-1978, (byte serial, bit parallel).

DISPLAY

CRT Type — Direct view storage.
Graphic Resolution — 4096 x 3120 viewable points; 4096 x 4096 addressable points.
Dimensions — 385 mm x 282 mm (15 in x 11 in); 482 mm (19 in) diagonal.
Visibility — Flicker-free.
Alphanumeric — Up to 132 character/line, 64 lines, four sizes.
Special fonts — Selectable under program control-Swedish, German, British, Spanish, Danish/Norwegian, Graphic and Business.
Graphics — Vector drawing time — 15 k cm/s.
Addressable Resolution — 4096 X x 3120 Y Dot-dashed vectors, programmable in 36 visibly distinct patterns.

KEYBOARD

Normal Keyboard — 128 characters (full ASCII) upper and lower case with auto repeat.
User Definable Function Keys — Ten-shiftable to 20.
Numeric Function Keys — Ten.
Line/Character Editor Keys — Five.
Cursor Position Control — Thumbwheels.
Cursor Type — Cross-hair.

CENTRAL PROCESSING UNIT

Processor — LSI bipolar 16 bit.
Memory Workspace — 32 kbytes or 64 k with Option 24.
Dynamic Range — $\pm 10^{-308}$ to $\pm 10^{308}$.
Numeric Accuracy — 14 decimal digits (12 displayed).
Programming Language — High level BASIC with extensions.

TAPE DRIVE

Cartridge — Magnetic.
Type — 300A, 300XL, and 600A Certified Data Cartridges from Tektronix. 300 k, 450 k, or 600 kbytes.
Rewind Speed — 90 ips.
Search/Read Speed — 30 ips.
Structure — 256 bytes w/header.

AC POWER

Voltage Ranges — 100 V ac, 110 V ac, 120 V ac or 220 V ac, 240 V ac.
Line Frequency — 48 Hz to 66 Hz.
Power — 360 W maximum.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	674	26.3
Height	513	20.0
Depth	840	32.7
Weight	**kg**	**lb**
Net	65.8	145.0

Operating Temperature Range — +10°C to +40°C.

INCLUDED ACCESSORIES

System software tape (020-0160-04); system software back-up tape (020-0161-04); power cord (161-0066-00); pkg of 10 blank user definable key overlays (334-2630-02); basic and GPIB enhancements reference; 4050 series graphic system operator's manual; 4050 series graphic system reference manual; introduction to programming in basic manual; introduction to graphic programming in basic manual; firmware instructions version 5.1/1.3 manual; reference guide to 4050 series basic.
Note: a full line of optional accessories are available.

ORDERING INFORMATION

4054A Desktop Computer **$12,950**
Option 01 — Data Communication Interface ..... +$600
Option 02 — Four Slot ROM Backpack ..... +$400
Option 03 — Data Communications Interface, Four Slot ..... +$900
Option 10 — RS-232 Printer Interface ..... +$550
Option 24 — 64 Kbytes Total Memory ..... +$290
Option 27 — 256 Kbytes Extended Memory File Manager ..... +$2,400
Option 28 — 512 Kbytes Extended Memory File Manager ..... +$3,200
Option 30 — Dynamic Graphics ..... +$1,995
Option 31 — Color Enhanced Dynamic Graphics .... +$1,995

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN** REFER TO PAGE 41

N1 — Service Plan + 9 Months Service ..... +$1,155

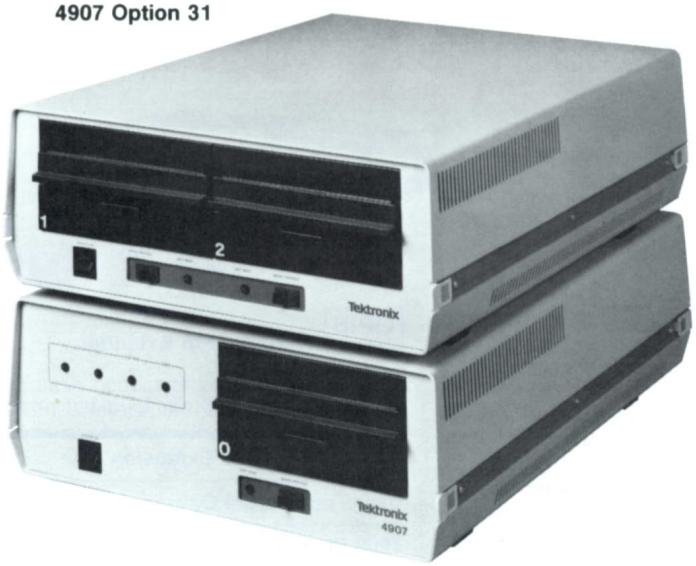
ROM PACKS FOR THE 4052A/4054A

4052R06 Editor ROM Pack **$495**
4052R07 Signal Processing ROM Pack #1 ..... **$250**
4052R08 Signal Processing ROM Pack #2 ..... **$495**
4052R09 Real-Time Clock ROM Pack **$495**
4052R10 Advanced File Manager ROM Pack (for 4909) **$400**
4052R11 Character and Symbol ROM Pack **$495**
4052R12 Graphics Enhancement ROM Pack **$495**
4052R14 GPIB Enhancement ROM Pack **$495**

Tektronix offers user training classes in the 4050 Series Desktop computers. For further information, contact the Customer Training Registrar at (503) 685-3808 or your nearest Tektronix Sales Office.

OEM terms available on this product.

4907 Option 31



4924

4907 File Manager

4050 Series Compatible

Built-In ROMs

The 4907 File Manager is a direct-access, flexible-disk device with a double density read/write feature. Its advanced multiple-level, file-by-name system includes a directory that maintains the user files, passwords and available space. Several drives may be connected to the 4907 for additional storage capacity.

Built-in ROMs and special 4050 Series ROM Packs contain the 4907 operating system software. No 4050 Series memory is required to support the operating system. The 4907 can also be used with some of the 4010 Series of graphic terminals.

CHARACTERISTICS

User-Available Storage Per Disk — 630 kbytes.

Tracks Per Disk — 77 max.

Sectors Per Track — 32.

Bytes Per Sector — 256.

Rotational Speed — 360 rpm.

Average Access Time — 340 ms.

Transfer Time — 4.2 ms/sector.

AC POWER

Line Voltage — 100 V ac to 240 V ac.

Line Frequency — 50 Hz to 60 Hz.

Power — 200 W at 120 V ac, 60 Hz max.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	520	20.3
Height	195	7.7
Depth	640	25.7
Weight	**kg**	**lb**
Net	27.5	60.0

INCLUDED ACCESSORIES

4051 File Manager ROM Pack (020-0279-00); power cord (161-0066-00); 6.5 ft 2 meter double shielded GPIB I/F cable (012-0630-03); box of 10 cleaning pads (006-2398-00); 0 to 9 label set (334-3340-00); installation guide; operator's manual; pocket reference card.

ORDERING INFORMATION

4907 File Manager **$1,600**

Option 30 — Two Disk Drives Total **$1,400**

Option 31 — Three Disk Drives Total **$2,400**

Option 40 — 4052/4052A or 4054/4054A Compatible ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service **$385**

4924 Tape Drive

GPIB IEEE-488 Compatible

Easy-to-Use Data Storage/Retrieval

The 4924 Digital Cartridge Tape Drive provides reliable, easy-to-use data storage and retrieval for the Tek 4050 Series Desktop Computers. Up to 15 tape drives can be mutiplexed to a 4050 acting as a controller on the GPIB. A single 4924 drive allows concurrent handling of merge operations, and input/output transactions.

CHARACTERISTICS

Cartridge Type — 300A, 300XL, 600A Certified Data Cartridges from Tektronix.

Usable Tape Length — 300 ft, 450 ft, 600 ft.

Storage Capacity — Up to 600 kbytes.

Characters/Record — 128/256 eight-bit bytes.

Recording Density — 1600 bpi.

Data Format — 8-bit binary or 8-bit ASCII.

Number of Data Tracks — Two.

Recording Format — NRZ two-track, self-clocking.

Read/Write Speed — 762 mm/s (30 ips).

Skip Forward/Reverse — 762 mm/s (30 ips).

Fast Forward/Rewind — 2.286 m/s (90 ips).

System Error Rate — One in 10^7 or less.

Start Time Read/Write — 25 ms.

Start Time Fast Forward/Rewind — 75 ms.

AC POWER

Line Voltage Range — 100 V ac to 240 V ac (jumper selectable).

Line Frequency — 50 Hz to 60 Hz.

Power — 62 W at 115 V ac.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	220	8.7
Height	152	6.0
Depth	438	17.2
Weight	**kg**	**lb**
Net	7.7	17.0

INCLUDED ACCESSORIES

Power cord (161-0066-00); 6.5 ft 2 meter GPIB I/F Cable (012-0630-01); operator's manual; operator's card; tape cartridge.

ORDERING INFORMATION

4924 Digital Cartridge Tape Drive **$2,990**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro, 220 V/16 A, 50 Hz

Option A2 — UK, 240 V/13 A, 50 Hz

Option A3 — Australian, 240 V/10 A, 50 Hz

Option A4 — North American, 240 V/15 A, 60 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$260**

OPTIONAL ACCESSORIES

300A Certified Data Cartridge — From Tektronix (box of 5, 300 ft ea). Order 119-0680-01 ..... **$120**

300XL Certified Data Cartridge — From Tektronix. Order 119-1439-00 ..... **$35**

600A Certified Data Cartridge — From Tektronix. Order 119-1463-00 ..... **$45**

GPIB I/F Cable — 3 meter (9.75 ft) (4924). Order 012-0630-01 ..... **$75**

GPIB I/F Cable — 4 meter (13 ft) (4927) Order 012-0630-02 ..... **$115**

Service Manual

GPIB IEEE-488

4909

Multi-User File Management System

The 4909 complies with IEEE Standard 488-1978.

Shared Access up to 10 Users

Public and Private File Workspaces for Operational Flexibility/File Protection

32 or 96 Mbyte Drive Capacity

Expandable up to 8 Drives (768 Mbytes)

Indexed and Dynamically Allocated Files

Variable Length Records

Time of Day Clock with Battery Backup

The 4909 Multi-User File Management System is a high performance mass storage system based on a controller that provides advanced file management between up to ten desktop computers and large capacity hard-disk drives. Flexible file management and a multiple level library structure provides multiple file access levels, indexed (keyed) file support, directly addressable bytes within records, expandable records and files, and enhanced data storage and retrieval. Permitting host interfacing flexibility, plug-in options include additional disk drives for expanded capacity.

Mass Storage Expandability

The 4909 offers 32 Mbytes of data storage capacity as standard. Optionally, 96 Mbytes of storage capacity are available. Each drive comes with a 16 Mbyte removable disk cartridge allowing data transportability and fast backup. For increased capacity, additional disk drives can be added by acquiring the 4909AC Auxiliary Cabinet. This cabinet will hold one or two additional disk drives of either 32 or 96 Mbyte capacity. Interconnection with the 4909 is by a plug-in disk interface that can support two hard disk drives. A maximum of four disk interface plug-ins can be used on the 4909, supplying a maximum of 768 Mbytes of online mass storage capacity.

File Security

Several levels of file security are provided by the 4909. The removable disk cartridge allows large collections of files to be completely removed from the 4909 and placed in a physically secure place. For archival storage, the removable cartridge is highly effective.

Multi-User Access

The cost effectiveness and contribution to productivity of a mass storage system is enhanced when two or more users are allowed to share information simultaneously. The 4909 allows the sharing and updating of files by up to ten users. Private file access is permitted after users supply a User-ID and password. Access is permitted to a private file workspace if the user entry matches a predefined User-ID list maintained by the 4909.

Indexed Files

For users requiring faster, more flexible access to record information stored in files, the 4909 provides indexed or keyed files.

Each record can be stored and retrieved on the basis of an alphanumeric key. The key used might be an employee's name or a product reference number. With indexed files, information can be better organized, and quickly retrieved.

Variable Length Records

Variable length records are supported by the 4909 to provide additional flexibility in creating and updating files. This allows records to change in accordance with user requirements.

ROM Pack Operation

Access to the 4909 from the 4050 Series of desktop computers will be via GPIB interfacing used in conjunction with a ROM pack to provide file management operation. ROM packs for the 4050 Series include the 4051R10 for use with the 4051, and the 4052R10 for use with the 4052/4052A or 4054/4054A.

GPIB Extender

A plug-in GPIB extender provides a cost-effective way to connect to remotely located, 4050 Series desktop computers or any IEEE Standard 488 compatible instruments, allowing communication over distances of up to 500 m (1650 ft).

CHARACTERISTICS

Capacity Per Drive — 32 Mbytes or 96 Mbytes (16 removable).
Disk Data Transfer Rate*1 — 1.2 Mbytes/s.
GPIB Data Transfer Rate*1 — 240 kbytes/s max burst.
Average Access Time — 30 ms.
Average Latency Time — 8.33 ms.
Recoverable Error Rate — Two in 10^{10} bits.
Number of Tracks/Inch — 384.
*1 *Actual transfer rates are application and computer dependent.*

AC POWER

Line Voltage and Frequencies — 120 V ac at 60 Hz, 240 V ac at 50 Hz, 100 V ac at 50 Hz or 60 Hz.
Power — 1150 W max at 120 V ac, 60 Hz.

PHYSICAL CHARACTERISTICS

	Dimensions				Weight
	Width	Height	Depth		Net
mm	565	760	850	kg	137
in	22.2	30.0	33.5	lb	302.0

INCLUDED ACCESSORIES

13 ft 4 meter GPIB interface cable (012-0630-04); 16 Mbyte cartridge disk (119-1462-00); system operator's manual; 4909 site preparation sheet; instruction manual.

ORDERING INFORMATION

4909 Multi-User File System **$16,000**

OPTIONS/FIELD UPGRADES

Option 33 — 96 Mbytes Disk ..... **+$2,000**
4909AC — Auxiliary Cabinet **$13,000**
4909F01 — GPIB Interface **$1,600**
4909F02 — GPIB Extender **$2,095**
4909F03 — Disk Interface **$1,600**
4909F10 — Controller Expansion **$1,000**
4051R10 — ROM pack for 4051 ..... **$300**
4052R10 — ROM pack for 4052/4052A or 4054/4054A .. **$400**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz

WARRANTY-PLUS **SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$1,240**

GPIB IEEE-488

4932 GPIB Extender

The 4932 is designed to support other products that comply with IEEE Standard 488-1978.

Up to 500 m GPIB Extension

User Transparent Operation

4909 Plug-in Option

The 4932 is a general purpose interface bus extender that provides a cost-effective way to interconnect IEEE Standard 488 compatible instruments, and allows GPIB communication over distances of up to 500 meters (1650 feet). The 4932 extends the range of standard length GPIB cables by using a 75 Ω RG 6/U coaxial "link" cable and operates transparently to the user. Two versions of this Tektronix product are available: the 4932, a self-powered unit, and the 4909F02 Plug-in Interface. The 4932 converts parallel GPIB data to serial form, appending various control signals and then transmitting the data to the remote end over the coaxial "link" cable. The 4909F02 was primarily designed for use with the Tektronix 4909 Multi-User File Management System. It plugs directly into the system bus and provides a coaxial "link" cable connector for use with a remote 4932. At the remote end, a 4932 GPIB Extender converts the data back to a parallel, GPIB compatible format.

CHARACTERISTICS

PERFORMANCE CHARACTERISTICS

Data Transfer Rates — Distance up to 300 m: 20 kbyte/s. Distance 300 to 500 m: 5 kbyte/s. SRQ Propagation Delay (300 m): 23 μs max.

AC POWER (4932 ONLY)

Line Voltage Ranges — 100 V ac, 120 V ac at 0.2 A; 220 V ac, 240 V ac at 0.1 A.
Line Frequency Range — 48 Hz to 400 Hz.

PHYSICAL CHARACTERISTICS

	4932		4909F02	
Dimensions	mm	in	mm	in
Width	238	9.4	31	1.2
Height	89	3.5	259	10.2
Depth	285	11.3	409	16.1
Weight ≈	kg	lb	kg	lb
Net	2.7	6.3	0.9	2.0

INCLUDED ACCESSORIES

Instruction Manual

ORDERING INFORMATION

4932 GPIB Extender **$1,195**
4909F02 GPIB Extender **$2,095**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

WARRANTY-PLUS **SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$45**

OPTIONAL ACCESSORIES

Coaxial Interface Cable (50 ft) RG 6/U —
Order 012-1051-00 ..... **$50**
Coaxial Interface Cable (200 ft) RG 6/U —
Order 012-1052-00 ..... **$105**

OEM terms available on these products.

4611

4611 Hard Copy Unit

Low Copy Cost

High Contrast, Permanent Images

Electrostatic Process

Storage Tube Compatible

The 4611 provides low cost, high quality copies of complex graphics and alphanumerics from storage tube displays at the press of a button. The 4611 is based on electrostatic (charge transfer) technology, and uses electrographic paper for high contrast, permanent copies at an economical per-copy cost.

The 4611's high addressability and dot overlap result in uniquely dark, smooth lines for optimum copy quality. The dry toning system employed by the 4611 is cleaner, more convenient and more consistent than liquid toning systems. Images are permanently fused and made from inert, safe ingredients. Typical user applications include quick preview copies before final plotting, copies of intermediate steps during interactive work sessions, and final output copies for reports, presentations, and file records.

Compact and lightweight, the 4611 can be easily moved from desk to desk. It also can be multiplexed to copy up to four teminals and/or display monitors. Warm up lights and paper-out indicators are provided.

The 4611 is compatible with the Tektronix 4010 Series of Computer Display Terminals, the (4114, 4114A, 4116A, 4025, and the 4025A) Terminals, the 4050 Series of Graphic Computing Systems, and the 4081 Interactive Graphics Terminal. The 4611 is also compatible with Tektronix 11 and 19 inch computer display modules.

CHARACTERISTICS

Warm-up Time — Two minutes.
Copy Time — 24 s (vertical format).
Paper Type — Electrographic (dielectric).
Image Size — Vertical Format: 190 mm x 147 mm (7.5 in x 5.8 in). Landscape Format (Option 01): 190 mm x 254 mm (7.5 in x 10 in). Option 31: 190 mm x 226 mm (7.5 in x 8.9 in).
Addressability — Vertical: 171 dots/in. Horizontal: 256 dots/in.
Toner — Dry magnetic.

AC POWER

Voltage Range — 90 V ac to 128 V ac and 180 V ac to 250 V ac. (High range requires Options A1, A2, A3 or A4).
Line Frequency — 48 Hz to 62 Hz.
Power — Warm-up: 300 W nom, 370 W max. Operating: 215 W nom, 290 W max. Idle: 120 W nom, 185 W max.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	425	16.7
Height	181	7.1
Depth	625	20.6
Weight	**kg**	**lb**
Net	20.0	45.0

INCLUDED ACCESSORIES

Power cord (161-0066-00); 10 ft 15-pin hard copy cable (012-0547-00); 2 rolls/case electrographic paper (006-2838-00); 4.9 oz dry copy toner (006-2990-00); operator's manual.

ORDERING INFORMATION

4611 Hard Copy Unit **$4,550**
Option 01 — Landscape Image Format ..... **+$150**
Option 02 — Four-Channel Multiplexer ..... **+$600**
Option 31 — Compatible with 4025 and 4025A Terminals. (Not required if Option 01 is ordered.) ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$515**

OPTIONAL ACCESSORIES

Interconnect cable 14-pin (20 ft) — Order 012-0548-00 ..... **$220**
Interconnect Cable 15-pin (50 ft) — Order 012-0549-00 ..... **$425**
Extender Cable (for servicing only) — Order 175-3421-00 ..... **$36**

PAPER & TONER

Electrographic Paper (2 rolls/case) — Order 006-2838-00 ..... **$35**
Dry Copy Toner (4.9 oz) — Order 006-2990-00 ..... **$22**

4631 Hard Copy Unit

High Image Quality, Copies in Seconds

Fiber Optic Process

Storage Tube Compatible

The 4631 Hard Copy Unit provides superior quality copies of any graphic and alphanumeric information displayed on a storage tube display. The 4631's fiber optic process uses Dry Silver paper for the fine detail and photographic quality image needed when copying complex graphics and alphanumerics. It requires no toners or chemical additives of any kind. Copies can be made in either vertical or horizontal format. A special "slow scanning" mode allows images on the horizontal format to be made at even higher resolution and image quality.

The 4631 can be multiplexed to copy up to four storage tube terminals and/or display monitors. It is compatible with the Tektronix 4010 Series of Computer Display Terminals, the 4114B and 4116B Terminal, the 4025 and 4025A Terminal,the 4050 Series of Graphic Computing Systems, and the 4081 Interactive Graphics Terminal. The 4631 is also compatible with Tektronix 11 and 19 inch computer display modules.

4631

CHARACTERISTICS

Warmup Time — Ten minutes.
Normal Scan — 18 s first copy; 9 s subsequent.
Slow Scan — 36 s first copy; 16 s subsequent.
Paper Size — 216 mm x 277 mm (8.5 in x 11 in).
Paper Type — Std Dry Silver (500 ft roll).
Addressability, Normal Scan — Vertical: 79 dots/cm (200/in). Horizontal: 67 dots/cm (170/in).
Slow Scan — Vertical: 118 dots/cm (300/in). Horizontal: 134 dots/cm (340/in).
Image Size — Vertical Format: 180 mm x 137 mm (7.1 in x 5.4 in). Horizontal Format: 225 mm x 170 mm (8.85 in x 6.7 in). Option 31: 163 mm x 190 mm (6.4 in x 7.5 in).

AC POWER

Voltage Range, Standard — 104 V ac to 126 V ac.
Strappable Low Range — 90 V ac to 110 V ac.
Strappable High Range — 108 V ac to 132 V ac.
Power, Warmup — 620 W nom; 750 W on high range.
Power, Copy Process — 200 W nom; 240 W on high range.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	406	16.0
Height	295	11.6
Depth	648	25.5
Weight	**kg**	**lb**
Net	29.5	65.0

INCLUDED ACCESSORIES

10 ft 15-pin interconnect cable (012-0547-00); 500 ft roll standard dry silver paper (006-1603-00); user's manual.

ORDERING INFORMATION

4631 Hard Copy Unit **$5,950**
Option 01 — Copy Counter ..... **+$120**
Option 02 — Four Channel Multiplexer ..... **+$660**
Option 31 — Compatible with Tektronix 4025 and 4025A Terminals ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A 50 Hz
Option A2 — UK 240 V/13 A 50 Hz
Option A3 — Australian 240 V/10 A 50 Hz
Option A4 — North American 240 V/15 A 60 Hz
Option A5 — Switzerland, 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$600**

OPTIONAL ACCESSORIES

Interconnect Cable 15-pin (20 ft) — Order 012-0548-00 ..... **$220**
Interconnect Cable 15-pin (50 ft) — Order 012-0549-00 ..... **$425**
Service Manual

4612

4612 Video Hard Copy Unit

Low Copy Cost

High Contrast, Black and White Images

Electrostatic Process

Video Source Compatible

Hard copy units such as the 4612 provide quick and convenient copies of complex information that has been displayed on a screen. These devices are essential to the use of graphic terminals, desktop computing systems, and video image processing systems. To fulfill a variety of user needs, graphic and alphanumeric information is permanently recorded on paper at the press of a button. These needs include quick preview copies before final plotting, copies of intermediate steps during interactive work sessions, and final output copies for reports, presentations, and file records.

The 4612 provides permanent black-and-white copies of graphic and alphanumeric information from raster scan terminals and other video signal sources. Based on electrostatic technology, the 4612 uses electrographic paper for high contrast copies at an economical copy cost. The 4612 is compatible with the Tektronix 4025A terminal, the 4112A Option 11 terminal, and with a wide variety of raster scan terminals and video signal sources including DEC VT100 Series terminals, DEC MINC Systems and those sources that produce RS-170, RS-330 or RS-375A type signals.

The 4612 is compact and lightweight, and can easily be moved from desk to desk. Its unique dry toning process is convenient, non-messy and superior to liquid toner systems. Images are permanently fused and made from inert, safe ingredients. Warm-up lights and paper-out indicators are provided. All copies are vertically oriented. The 4612 can be multiplexed to copy up to four terminals and/or display monitors with Option 02.

The standard 4612 unit is prepared for use with 525 line, 60 Hz sources. Adjustment for 625 line, 50 Hz is provided as an option.

CHARACTERISTICS

Warm-up Time — Two min.
Copy Time — 24 s.
Paper Type — Electrographic (dielectric).
Image Size — 7.5 x 5.8 std (525 line, 60 Hz signals).
Addressability — Horizontal: 256 dots/in. Vertical: 171 dots/in.
Toner — Dry magnetic.

AC POWER

Voltage Range — 90 V ac to 128 V ac and 180 V ac to 250 V ac. (High range requires Options A1, A2, A3 or A4.)
Warm-up — 300 W nom, 370 W max.
Copy Process — 215 W nom, 290 W max.
Idle — 120 W nom, 185 W max.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	425	16.7
Height	181	7.1
Depth	525	20.6
Weight ≈	**kg**	**lb**
Net	20.0	45.0

INCLUDED ACCESSORIES

Power cord (161-0066-00); 2 rolls/case electrographic paper (006-2838-00); 4.9 oz dry copy toner (006-2990-00); 10 ft BNC interconnect cable (175-2753-00); operator's manual.

ORDERING INFORMATION

4612 Video Hard Copy Unit **$4,400**
Option 02 — Four-Channel Multiplexer ..... **+$600**
Option 03 — Setup for 625/50 Hz Scanning Std ..... **NC**
Option 08 — Setup for DEC VT100 Series Terminals ..... **NC**
Option 15 — Video Input 15-pin Connector ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$515**

OPTIONAL ACCESSORIES

Service Manual
Interconnect Cable, BNC (10 ft) — Order 175-2753-00 **$23**
Interconnect Cable, BNC (25 ft) — Order 012-0157-00 .. **$100**
"T" Connector, BNC — Order 103-0030-00 ..... **$6.50**
Interconnect Cable, 15-pin (10 ft) —
Order 012-0504-00 ..... **$135**
Interconnect Cable, 15-pin (20 ft) —
Order 012-0504-01 ..... **$155**
Interconnect Cable, 15-pin (50 ft) —
Order 012-0504-02 ..... **$180**
Extender Cable (For servicing only) —
Order 175-3421-00 ..... **$36**
Remote Copy Button — Order 016-0722-00 ..... **$100**
Remote Copy Button and 25 ft Cable —
Order 016-0722-01 ..... **$165**
Remote Copy Button and 50 ft Cable —
Order 016-0722-02 ..... **$200**
25 ft Cable for Remote Copy Button —
Order 012-0985-00 ..... **$65**
50 ft Cable for Remote Copy Button —
Order 012-0986-00 ..... **$100**
PAPER & TONER
Electrographic paper, (2 rolls/case) —
Order 006-2838-00 ..... **$35**
Dry Copy Toner, (4.9 oz) — Order 006-2990-00 ..... **$22**

4632 Video Hard Copy Unit

High Image Quality

Gray Scale Capability

Copies in Seconds

Video Source Compatible

The 4632 provides permanent copies of graphic and alphanumeric information from raster scan terminals and other video signal sources. All copies are horizontally oriented. Eight distinct shades of gray can be copied with a special gray scale enhancement option. The standard 4632 can clearly show six different shades of gray, for polygon fill-in, bar charts, and many other applications.

With Option 02, the 4632 can be multiplexed to copy up to four raster scan terminals, and can accept remote copy signals. The 4632 is compatible with the Tektronix 4020 Series, 4112, 4112A, 4113, 4113A terminals and with a wide variety of raster scan terminals and video signal sources, including those that produce RS-170, RS-330, RS-375A, RS-343A and RS-412A type signals. The 4632 is also compatible with VT100 Series terminals, the HP 2640 Series, the AT&T Gemini 100 Systems, and an optional RGB mixer provides 4632 compatibility with many color displays such as the IBM 3279.

The standard 4632 is prepared for use with 525 line, 60 Hz sources. Many other adjustments are provided as options, including adjustments for 625 line, 50 Hz and for high resolution 1029 line, 60 Hz.

4632

CHARACTERISTICS

Warmup Time — Ten minutes.
Copy Time — 18 s first copy; 9 s subsequent copies.
Paper Size — 216 mm x 277 mm (8.5 in x 11 in).
Paper Type — Std Dry Silver (500 ft roll).
Addressability — Incoming signal dependent.
Image Size — 203 mm x 152 mm (8 in x 6 in).
Gray Levels — Six min (8 w/Option 06).

AC POWER

Voltage Range, Standard — 104 V ac to 126 V ac.
Strappable Low Range — 90 V ac to 110 V ac.
Strappable High Range — 108 ac to 132 V ac.
Warmup — 620 W nom, 750 W max.
Copy Process — 200 W nom; 240 W max.
Idle — 120 W nom, 185 W max.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	406	16.0
Height	295	11.6
Depth	648	25.5
Weight ≈	**kg**	**lb**
Net	29.5	65.0

INCLUDED ACCESSORIES

500 ft roll standard dry silver paper (006-1603-00); 75 Ω BNC terminator (011-0102-00); user's manual.

The 4632 is not shipped with an interconnect cable; order the desired cable from the following optional accessories list.

ORDERING INFORMATION

4632 Video Hard Copy Unit **$6,050**
Option 01 — Copy Counter ..... **+$120**
Option 02 — Four Channel Multiplexer ..... **+$660**
Option 03 — Setup for 625 Line/50 Hz ..... **NC**
Option 04 — Setup for 1029 Line/60 Hz ..... **NC**
Option 05 — Setup for Tektronix 4023 Terminal ..... **NC**
Option 06 — Enhanced Gray Scale ..... **+$840**
Option 07 — Compatible with HP 2640 Series Terminals ..... **+$125**
Option 08 — Compatible with DEC MINC Systems .. **+$125**
Option 09 — Setup for AT&T GEMINI 100 Systems . **+$125**
016-0596-00 — RGB Mixer **$395**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$600**

OPTIONAL ACCESSORIES

Interconnect Cable, 15-pin (10 ft) —
Order 012-0504-00 ..... **$135**
Interconnect Cable, 15-pin, (20 ft) —
Order 012-0504-01 ..... **$155**
Interconnect Cable, 15-pin, (50 ft) —
Order 012-0504-02 ..... **$180**
Interconnect Cable, BNC, 75 Ω (25 ft) —
Order 012-0157-00 ..... **$100**
Service Manual
Remote Copy Button — Order 016-0722-00 ..... **$100**
Remote Copy Button and 25 ft Cable —
Order 016-0722-01 ..... **$165**
Remote Copy Button and 50 ft Cable —
Order 016-0722-02 ..... **$200**
25 ft Cable for Remote Copy Button —
Order 012-0985-00 ..... **$65**
50 ft Cable for Remote Copy Button —
Order 012-0986-00 ..... **$100**
RGB Video Mixer — Order 016-0596-00 ..... **$395**
PAPER
Standard Dry Silver Paper (500 ft roll) —
Order 006-1603-00 ..... **$90**
Standard Dry Silver Paper, (4 rolls/carton) —
Order 006-1603-01 ..... **$320**

OEM terms available on these products.

4634

4634 Imaging Hard Copy Unit

Excellent Gray Scale and Resolution

The 4634 Imaging Hard Copy Unit records images of photographic quality from most TV video sources, both analog and digital.

The 4634 can be quickly adjusted to accommodate a wide variety of line rates, for both 50 Hz and 60 Hz systems.

It uses a fiber-optic CRT and thermal processor to produce a finished image with excellent resolution and gray scale in less than half a minute. Cost per copy for large, file-sized images is low. An optional RGB mixer provides 4634 compatibility with many color displays such as the IBM 3279.

Video information is input through rear panel connectors. In most cases a simple BNC connector is all that's required.

The 4634 is available as either a rackmount or benchtop model.

CHARACTERISTICS

Recording Medium — Dry Silver Paper; Tektronix' High Performance (7772) Paper or switch selectable to Tektronix' Standard (7770) Paper.

Paper Packaging — Rolls of paper encased in light-sealed cylindrical cassettes.

Paper Dimensions — 216 mm x 152 m (8.5 in x 500 ft).

Shelf Life of Tektronix Paper — 12 months at +20°C with 50% relative humidity.

Recording Technique — Raster scan video with fiber optic CRT.

Developing Technique — Heat via internal processor.

Warmup Time — 20 min.

Copy Time — 26 s.

Exposure Time (11 in Copy) — 8.5 s.

Copy Repetition Rate — ≈12 s.

Copy Length Range — 178 mm to 279 mm (7.0 in to 11.0 in) in 19 mm (¾ in) increments.

Horizontal Image Size Range — 127 mm to 203 mm (5 in to 8 in) for 60 Hz field rate; 152 mm to 203 mm (6 in to 8 in) for 50 Hz field rate.

Vertical Image Size Range — Adjusts for correct aspect ratio.

Gray Shades — 12 w/Tektronix High Performance (7772) Paper. Six w/Tektronix Standard (7770) Paper.

Resolution — At least 4.92 lines/mm (125 lines/in) w/Tektronix High Performance (7772) Paper. At least 3.94 lines/mm (100 lines/in) w/Tektronix Standard (7770) Paper.

AC POWER

Line Voltage Range (±10%) — Jumper selectable for 100 V ac, 115 V ac, 120 V ac, 200 V ac, 220 V ac, 230 V ac and 240 V ac.

Line Frequency — 48 Hz to 62 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	425	16.7
Height	266	10.5
Depth	686	27.0
Weight ≈	**kg**	**lb**
Net	30.5	67.0

INCLUDED ACCESSORIES

500 ft roll high performance dry silver paper (006-2432-00); 75 Ω terminator (001-0131-00); instruction manual (for 4634 OEM); instruction manual (for 4634 Option 45).

The 4634 is not shipped with an interconnect cable; order the desired cable from the following optional accessories list.

ORDERING INFORMATION

4634 Imaging Hard Copy Unit **$7,900**
Option 30 — Delete Rackmount Hardware ..... **−$85**
Option 45 — End-User Set-up ..... **NC**
016-0596-00 — RGB Mixer **$395**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$600**

OPTIONAL ACCESSORIES

Cable — 75 Ω (42 in) BNC. Order 012-0074-00 ..... **$17**
Board Extender — Order 067-0687-01 ..... **$135**
Card Extender — Order 067-0708-00 ..... **$95**
Interconnect Cable — 15-pin, (10 ft).
Order 012-0504-00 ..... **$135**
Interconnect Cable — 15-pin, (20 ft).
Order 012-0504-01 ..... **$155**
Interconnect Cable — 15-pin, (50 ft).
Order 012-0504-02 ..... **$180**
RGB Video Mixer — Order 016-0596-00 ..... **$395**

PAPER

High Performance Dry Silver Paper — 500 ft roll.
Order 006-2432-00 ..... **$215**
High Performance Dry Silver Paper — Four rolls/carton).
Order 006-2432-01 ..... **$750**

4643 Printer

Crisp, Matrix Quality Printing

Easy to Use

International Characters

High Reliability

A low cost alternative to conventional line printing, the Tektronix 4643 Printer provides fast, high-quality, impact printing while requiring no preventive maintenance and infrequent servicing.

Fast but not expensive, the 4643 Printer uses bi-directional operation to print 340 characters per second, printing full 132 character lines. Speeds of 125 lines per minute are nominal.

The 4643 provides three type faces: standard, condensed, and expanded. All three can be program selected, allowing users to mix the various fonts for greater reading impact.

Compatibility

The standard Tektronix 4643 can be interfaced with most standard RS-232 data processing instruments and systems. Option 01 provides a parallel interface. The 4643 is compatible with the following Tektronix products: 4010 and 4110

4643

Series terminals, 4020 Series terminals, and 4050 Series Desktop Graphic Computing systems; the 8001 and 8002A Microprocessor Labs and 8550 Microcomputer Development Lab; and the S-3250, S-3270, and S-3280 Semiconductor Test Systems.

CHARACTERISTICS

Printing Speed — 340 characters/s.

Character Density — Condensed: 219 characters/line. Standard: 132 characters/line. Expanded: 72 characters/line.

Throughput Rate — 132 Columns Wide: 125 lines/min. 72 Columns Wide: 200 lines/min. 40 Columns Wide: 300 lines/min.

Paper Slew Rate — 254 mm/s (10 in/s) min.

Character Set — 128 (96 ASCII plus 32 international).

Vertical (Line) Spacing — 2.4 lines/cm (6 lines/in).

Horizontal (Standard Character) Spacing — 3.9 characters/cm (10 or 5 characters/in).

Printing Matrix — 7 x 7 half-dot matrix.

Paper Type — Continuous fanfold, edge perforated.

Paper Width — 76.2 mm to 406.4 mm (3 in to 16 in) at 0.7 mm (0.028 in) maximum thickness.

Ribbon Type — Fabric, continuous loop cassette.

Ribbon Life — Five million characters.

AC POWER

Line Voltage — 90 V ac to 136 V ac or 187 V ac to 257 V ac.

Line Frequency — 50 Hz or 60 Hz.

Power, Idle — 150 W max.

Power, Printing — 275 W max.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	671	26.4
Height	213	8.4
Depth	594	23.8
Weight	**kg**	**lb**
Net	30.0	67.0

INCLUDED ACCESSORIES

Ribbon cassette (118-1314-00); operator's manual.

ORDERING INFORMATION

4643 Printer **(2400 Baud Standard)** **$4,200**
Option 01 — Parallel Interface ..... **NC**
Option 02 — Customer Specifies Baud Rate 110, 150, 300, 600, 1200, 4800, 9600. Use Option 61 to Indicate Choice ..... **NC**
Option 03 — 8550 Series Microcomputer Development Lab compatibility ..... **NC**
Option 61 — Required with Option 02. Select 110, 150, 300, 600, 1200, 4800, or 9600 ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro, 220 V/16 A, 50 Hz
Option A2 — UK, 240 V/13 A, 50 Hz
Option A3 — Australian, 240 V/10 A, 50 Hz
Option A4 — North American, 240 V/15 A, 60 Hz
Option A5 — Swiss 220 V/10 A, 50 Hz

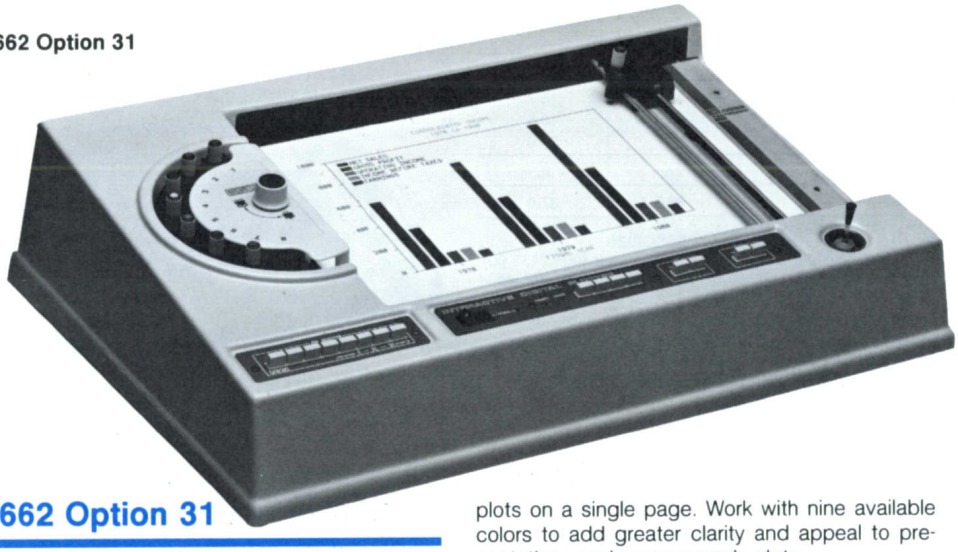
***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan +9 Months Service ..... **+$340**

OPTIONAL ACCESSORIES

Service Manual
Pedestal — Order 118-1335-00 ..... **$250**

4662 Option 31



4662 Option 31

Intelligent B-Size (A3) Plotter

8-Pen Turret Version

Compatible in RS-232C ASCII Environments

Supported by PLOT 10 and PLOT 50 Software

The 4662 is the first plotter with built-in processing power. It has the capability to operate independently, without bogging down computational operations. Input data is internally buffered so you can optimize data transfer from your host processor, or move on to your next computation while the 4662 is plotting. Incorporating state-of-the-art technology, it provides an accuracy and repeatability that no other plotter can approach for the price.

When turned on, the 4662 automatically adjusts for its nominal plot size regardless of how the last plot was set up. To set a different plotting area or adjust to a new paper size, you simply use the Set control buttons on the front panel to define the area. The 4662 plots on paper, vellum, mylar, acetate-film and preprinted forms.

The 4662's digital stepping motors and internal vector generator operate at high speed, with microprocessor-controlled acceleration and deceleration.

Excellent Repeatability

There is no servo hysteresis and no drift as in potentiometric feedback systems. There are no slidewires to clean, no moving electrical contacts, and no servo adjustments to be made.

8-Pen Turret

The 4662 Option 31 adds the convenience of an automatic 8-pen turret to the built-in processing and feature-packed performance of the world's most versatile small plotter. You can insert any eight pens and program the 4662 to make the selection for you. Mix and match hard-nib, fiber-tip and wet-ink pens. Include fine line widths for the most precise plots, or for drawing several plots on a single page. Work with nine available colors to add greater clarity and appeal to presentations and camera-ready plots.

Retrofit your present 4662 with the Option 31 turret. It can be installed quickly by any Tektronix service engineer. Updating existing programs to include programmed pen selection requires the addition of just a few lines of code.

Operating Modes

The 4662 Option 31 has two input modes in RS-232C: Alphanumeric (Alpha) and Graphic Plot (Graphic). The 4662 Option 31 also has Graphic input (GIN) to the host.

CHARACTERISTICS

Plotting Area — X-axis: >381 mm (15 in). Y-axis: >254 mm (10 in).

Repeatability — ±0.06 mm w/same pen, ±0.25 mm w/pen exchanged.

Time to Maximum Velocity — ≈120 ms.

Resolution — 0.127 mm (0.005 in).

Plotting Rate — 406 mm/s to 559 mm/s (16 to 22 ips) vector dependent.

Plotting Rate — User programmable from 10 mm/s to 570 mm/s in 10 mm/s increments.

Point Plotting Rate — Ten points/s max.

Character Set — Full ASCII.

Pen Control — Software or front panel Pen button; manually disabled.

Writing Method — Fiber-tipped pen, nylon tipped pen, or wet ink drafting pens.

Paper Size — 279 x 432 mm (11 x 17 in) max.

Paper Retainer — Electrostatic holddown.

Drive Characteristics — Two four-phase stepping motors, each operating a pulley/cable system to propel the pen in that motor's respective axis.

AC POWER

Voltage Ranges — 105 V ac, 116 V ac, 210 V ac, 232 V ac ±14% V ac.

Line Frequency — 48 Hz to 66 Hz.

Power — 60 W typical, 90 W max.

INCLUDED ACCESSORIES 4662 OPTION 31

Power cord (161-0066-00); RS-232 cable (012-0829-00); GPIB cable (std w/Opt 01) (012-0630-03); digitizing sight (119-1432-01); 100 sheets blank paper (006-2410-00); 9-pen, multicolor packs for paper (016-0414-09); operator's manual; programmer's reference manual; reference card.

ORDERING INFORMATION

4662 Interactive Digital Plotter
(Option 31 required) **$2,995**
Option 31 — 8-Pen Turret Included **$1,000**
Option 01 — GPIB I/F Cable instead of RS-232C I/F Cable ..... **NC**
Option 20 — 8 K Buffer ..... **+$495**
4662A01 — PLOT 10 Utility Routines Software **$460**
021-0339-00 — Option 31 Field Retrofit Kit for Std 4662 ..... **$1,500**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN** **REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$470**

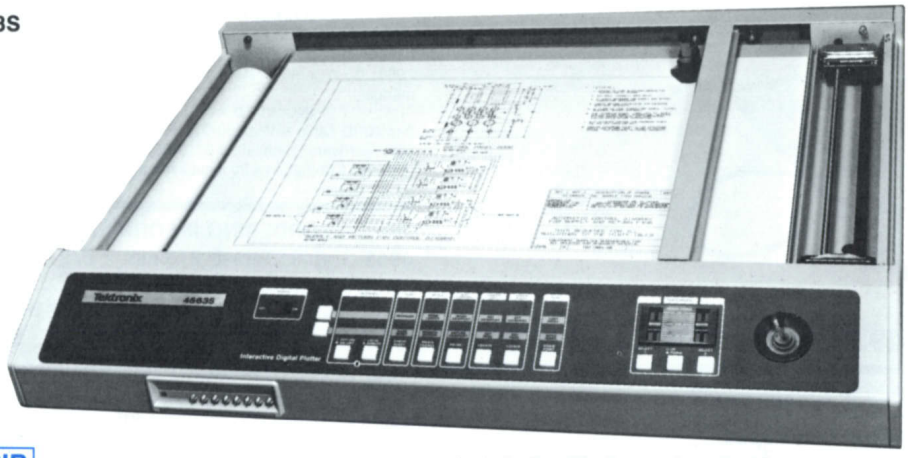
OPTIONAL ACCESSORIES 4662 OPTION 31

Pedestal — Order 016-0629-00 ..... **$420**
Dust Cover — Order 016-0462-00 ..... **$11.75**
Service Manual
Paper, Blank, 11 x 17 in (100 sheets/pkg) — Order 006-2410-00 ..... **$10**
Paper, Full Log, 2 x 3 cycle (11 x 16.5 in) — Order 006-1702-00 ..... **$12**
Paper, Linear, 10 x 10/in (11 x 16.5 in) — Order 006-1698-00 ..... **$12**
Paper, Linear, 10 x 10/cm (11 x 16.5 in) — Order 006-1699-00 ..... **$12**
Paper, Semi-Log, 10 x 3 cycle, (11 x 16.5 in) — Order 006-1700-00 ..... **$12**
Paper,Semi-Log, 10 x 2 cycle, (11 x 16.5) — Order 006-1701-00 ..... **$15**
GPIB Cable (4 meter) — Order 012-0630-02 ..... **$115**
Double Shielded GPIB Cable (2 meter) — Order 012-0630-03 ..... **$90**
Double Shielded GPIB Cable (4 meter) — Order 012-0630-04 ..... **$150**
"Quick Dry" Transparency Film (50 sheets/pkg) (8.5 in x 11 in) — Order 006-5939-00 ..... **$30**
Presentation Pack (Contains Film, Pens, Frames, Pen Tray and Storage Box) — Order 020-0888-00 ..... **$60**

Also see Supplies and Order Information for additional optional Accessories.

OEM terms available on these products.

4663S



GPIB IEEE-488

4663

The 4663 is designed to support other products which comply with IEEE Standard 488-1978.

Intelligent C-Size Plotter

Dual Programmable Pen Control

Nine Character Fonts

RS-232 and GPIB Product

The 4663 is the first high speed, C-size plotter with built-in processing power and 5.5 k buffer memory to free the host from many routine computations. This intelligent plotter saves time without sacrificing flexibility.

The 4663 can handle either European A-2 drafting size or American C-size paper, mylar or acetate. Fiber tip, hard-nib, or wet ink pens give you crisp, clean camera-ready copies or overhead transparencies.

A sprocket feed paper advance (Option 36) is available for roll stock, with form feed remotely or locally programmable. This option allows the 4663 to operate unattended with a variety of form sizes.

The plotter features dual programmable pen control with interchangeable multicolor pens and is capable of producing dotted or dashed lines from local firmware. A built-in joystick allows easy manual positioning of the pen carriage crosshairs for digitizing or page scaling adjustments.

Unique Parameter Entry Device

This front panel device lets you quickly identify or select operating parameters without resorting to binary switches, straps, status display devices, and volumes of operator manuals. It allows you to quickly program baud rate, pen type, acceleration, plotting speed, aspect ratio, page size and many other parameters.

Excellent Penmanship

Nine character fonts come standard with the 4663, including the full ASCII character set. All characters can be scaled, slanted, rotated and may be centered when used as pilot symbols.

Local Functions

Various graphic functions are implemented via firmware. Page scaling, windowing, viewporting and clipping are typical.

Hardware loop through RS-232C interface is standard and optional GPIB is available. The 4663 is designed to support other GPIB products that comply with IEEE Standard 488-1978.

The Tektronix 4932 GPIB Extender provides a cost-effective way to interconnect remotely located GPIB instruments, allowing communication at distances of up to 500 meters (1650 feet). See page 132 for additional information.

CHARACTERISTICS

Maximum Plotting Area — X-axis: 569 mm (22.4 in). Y-axis: 432 mm (17 in).

Repeatability — ±0.064 mm (±0.0025 in).

Resolution — ±0.025 mm (±0.001 in).

Maximum Plotting Speed — 406 mm to 559 mm (16 ips to 22 ips) vector dependent.

Point Plotting Rate — Ten points/s max.

Character Generator — 95 ASCII, 15 x 7 matrix, seven special fonts standard.

Paper Size — 420 mm x 594 mm (European A2), 17 in x 22 in (US C-size).

Paper Retention — Electrostatic hold down.

Media Types — Paper, mylar or acetate.

Drive Characteristics — Microprocessor controlled stepping motors controlling cable system connected to pen arm.

Baud Rate — 110 baud to 9600 baud.

Standard Interface — RS-232C, full duplex, loop-through.

AC POWER

Voltage Ranges — 90 V ac to 132 V ac and 180 V ac to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Power — 180 W typical.

4663S

Intelligent C-Size Plotter

RS-232 and GPIB Product

High Performance Features

As the first interactive digital plotter to combine large plotter capabilities with C-size workstation convenience, the 4663S typically does most of the work relegated to the largest flatbeds and drums at a tremendous savings in time and cost.

Using its dual-programmable pens, unique push-button parameter entry card, and the other high-performance features, you can enjoy easy command over many of the most sophisticated plotting tasks.

Features

In addition to the capabilities of the 4663, the 4663S offers the following high performance features as standard:

Integral GPIB and RS-232 Interface

This interface provides flexible plotter configurability with a variety of host computers, terminals and displays.

Circular Interpolation and Programmable Macros

These features allow the precise drafting of circles and arcs, and for quick drafting of stored graphics and symbols.

Added Default Parameters

These parameters permit as many as four groups of set-up instructions to be entered in plotter memory, with single-key recall.

Downloadable Math and Character Sets

These sets permit alphanumeric versatility with reduced host dependency.

PHYSICAL CHARACTERISTIC (4663/4663S)

Dimensions	mm	in
Width	995	37.6
Height	173	6.8
Depth	752	29.6
Weight	**kg**	**lb**
Net	386.0	85.0
Shipping	454.0	100.0

INCLUDED ACCESSORIES

Power cord (161-0066-00); RS-232 15 ft I/F cable (Std w/basic unit only) (012-0829-00); 6.5 ft 2 meter GPIB I/F cable (Std w/Opt 01, 04) (012-0630-03); pkg of 3 black fiber tip pen (016-0414-00); pkg of 3 red fiber tip pen (016-0414-02); pkg of 3 blue fiber tip pen (016-0414-06); pkg of 3 green fiber tip pen (016-0414-05); 100 sheets/box 17 x 22 in translucent white No 1 sulfite paper (006-3150-00); 2 rolls/box 18 in x 200 ft "C" size after tear off, blank roll paper (shipped w/Opt 36 only) (006-2837-00); operator's manual; reference guide.

ORDERING INFORMATION

4663 Interactive Digital Plotter **$9,990**

4663S Interactive Digital Plotter **$10,900**

Option 04 — GPIB only (deletes RS-232C for 4663) ..... **NC**

Option 36 — (4663) Paper Advance ..... **+$1,050**

Option 36 — (4663S) Paper Advance ..... **+$990**

4663A01 — PLOT 10 Utility Routines Software **$750**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 230 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$940**

OPTIONAL ACCESSORIES

Service Manual Vol I

Service Manual Vol II

Paper, Blank Roll, (2 rolls/box)
("C" Size after tear off) Order 006-2837-00 ..... **$40**

Paper, Blank Roll, (2 rolls/box)
(Metric Size A2 after tear off) Order 006-3473-00 ..... **$42**

Dust Cover, Soft Vinyl Order 200-2392-00 ..... **$25**

Vellum (100 percent reg), 17 in x 22 in
(100 sheets/box) Order 006-2836-00 ..... **$45**

Mylar, Antistat, 17 in x 22 in
(100 sheets/box) Order 006-2835-00 ..... **$120**

GPIB Cable, 4 meter (13 ft) Order 012-0630-04 ..... **$150**

"Quick Dry" Transparency Film,
8.5 in x 11 in, (50 sheets/pkg) Order 006-5939-00 ..... **$30**

Presentation Pack (Contains Film, Pens, Frames, Pen Tray and Storage Box)
Order 020-0888-00 ..... **$60**

Also see Supplies and Ordering Information for additional optional Accessories.

NEW

JOYSTICK AND GRAPHIC TABLETS

NEW 4957 Graphic Tablet

RS-232C Compatible

High Quality Graphic Input Capabilities for 4107 and 4109 Computer Display Terminals.

Easy to Use and Inexpensive to Own

Simple Four-Button Cursor Control

To use the 4957, merely touch the four-button cursor-puck to the tablet's active area. The tablet calculates the coordinates and relays them to the host computer for storage or manipulation.

Human Engineering Features

Include a 0 to 20 degree tilt; light weight (1.8 kg, 4 lbs); remote control of tablet functions from the host computer; a built-in controller for easier setup and a more compact design; and independence from periodic biasing or other adjustments.

Software Power

The 4957 tablet and 4107 or 4109 terminal is software compatible with Tektronix 4110 family of terminals and tablets.

The 4957 can operate in either an absolute coordinate system commonly found on a tablet or in a relative coordinate system commonly found on a graphics "mouse" or on thumbwheels.

CHARACTERISTICS

Size — 419 mm x 394 mm (16.5 in x 15.5 in).

Active Writing Area — 297 mm x 297 mm (11.7 in x 11.7 in).

Resolution — User selectable up to 1000 points/inch.

Speed — User selectable up to 90 coordinates/second.

Accuracy — ±.625 mm (0.025 in).

Repeatability — ±.250 mm (0.010 in).

INCLUDED ACCESSORIES

Power supply and cord (119-1773-00); 4-button cursor (119-1775-00); instruction manual.

ORDERING INFORMATION

4957 Graphics Tablet **$795**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro, 220 V/16 A, 50 Hz

Option A2 — UK, 240 V/13 A, 50 Hz

Option A3 — Australian, 240 V/10 A, 50 Hz

Option A4 — North American, 240 V/15 A, 60 Hz

Option A5 — Switzerland, 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$45**

4953/4954/4956 Graphic Tablets

Pen or Cursor Inputs

Worst Case Spec

With the 4953/54/56 Graphic Tablets, you can choose one of two input device options: a pen for best convenience or a push-button cursor where exacting accuracy is required. You can input points or vectors to digitize or display maps, graphic drawings, schematics and other designs.

The 4953 and 4954 have custom interfaces that let them work with the Tektronix 401X terminal family. The 4956 is an IEEE-488 device that connects to the 4050 Series Desktop Computers.

The 4954F32 Pedestal is a roll-around stand that allows the 4954 to be raised or lowered or tilted at any angle from vertical to horizontal.

CHARACTERISTICS (4953)

Size — 279 mm x 279 mm (11 in x 11 in).

Active Writing Area — 260 mm x 260 mm (10.24 in x 10.24 in).

Resolution — 0.25 mm (0.01 in) min (10 bits).

Accuracy — ±0.975 mm (±0.030 in) over entire surface.

Repeatability — One point.

Operating Modes — Single or multiple point entry using either optical cursor or pen.

4954

Size — 762 mm x 1016 mm (30 in x 40 in).

Active Writing Area — 780 mm x 975 mm (30.7 in x 38.4 in).

Resolution — 0.25 mm (0.01 in) min (12 bits).

Accuracy — ±2.5 mm (±0.10 in) over entire surface.

Repeatability — ±1 point.

Operating Modes — Single or multiple point entry using either optical cursor or pen.

4956

Size — 510 mm x 510 mm (20 in x 20 in); Option 33, 910 mm x 1220 mm (36 in x 48 in).

Resolution — 0.127 mm (0.005 in).

Accuracy — ±0.1 mm (0.004 in) ±1 LSB.

Repeatability — ±1/2 LSB.

Repetition Rate — Up to 30 CPS.

Operating Modes — Point, Stream, Switch Stream, Incremental.

AC POWER (4953/54, 56)

Line Voltage — 4953/4954: 94 V ac to 126 V ac or 187 V ac to 264 V ac.
4956: 100, 115, 230.

Line Frequency — 4953/4954: 48 Hz to 440 Hz.
4956: 48 Hz to 66 Hz.

Power — 4953/4954: 30 W max.
4956: 75 W max.

INCLUDED ACCESSORIES (4953/4954)

Reference card (070-1787-00); Pen w/inkless filler (119-0621-00); 4953: 11 in x 11 in bias magnet (119-0686-00); 4954: 30 in x 40 in bias magnet (119-0687-00); instruction manual.

INCLUDED ACCESSORIES (4956)

2 m GPIB cable (012-0630-01); PLOT 50 graphics tablet support software tape (020-0223-00); pen with inkless filler (119-0621-00); 20 in x 20 in bias magnet (119-0895-00); operator's manual.

ORDERING INFORMATION

4953 Graphic Tablet, 279 mm x 279 mm (11 in x 11 in) **$2,750**

4954 Graphic Tablet, 762 mm x 1016 mm (30 in x 40 in) **$4,950**

4956 Graphic Tablet, 510 mm x 510 mm (20 in x 20 in) **$5,670**

Option 33 — (4956) Graphic Tablet, 910 mm x 1220 mm (36 in x 48 in) ..... **+$2,600**

Option 48 — 220 V ac, 50 Hz Power ..... **NC**

4954F32 Pedestal (for 4954 or 4956 Option 33) **$1,325**

***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — (4953) Service Plan + 9 Months Service ..... **+$215**

N1 — (4954) Service Plan + 9 Months Service ..... **+$300**

N1 — (4956) Service Plan + 9 Months Service ..... **+$385**

OPTIONAL ACCESSORIES

Cursor — (1 Button, Replaces the Pen)
Order 119-0622-00 ..... **$315**

Pen Refill — Graphic Tablet, Blue Ink
Order 016-0334-00 ..... **$2.30**

Pen Refill — Graphic Tablet, Non-Inking
Order 016-0335-00 ..... **$3.60**

New Tablet Surface — (Plastic Replacement Only)
Order 118-0049-00 ..... **$35**

Cursor — (4 Button Replaces the Pen) (4956)
Order 119-0875-00 ..... **$430**

Service Manual (4956)

4952 Joystick

This sensitive fingertip cursor control allows quick, precise positioning of the cursor, making it easy to develop accurate graphics, with Tektronix 4010 Family Terminals, 4081 Interactive Graphic Systems and 4050 Series Desktop Computers.

The 4952 is Simplicity Itself

Just move the center lever in the direction you want to move the cursor. Speed is controlled by the angle and distance of the lever from the center position. When you want to stop the cursor, simply release the lever to its neutral vertical position.

CHARACTERISTICS

Control Actuation — Spring return to center.

Time Drift (Within 30-Second Period) — Adjustable to <1 part in 1024.

Cursor Control Accuracy — 0.1%.

Resolution (X and Y) — 1 part in 1024.

INCLUDED ACCESSORIES

Instruction manual for 4010 Series; instruction manual for Option 02.

ORDERING INFORMATION

4952 Joystick (4014/4015) **$625**

Option 01 — Joystick (for 4010, 4012, and 4013) ..... **+$75**

Option 02 — Joystick (for 4050 Series) ..... **+$100**

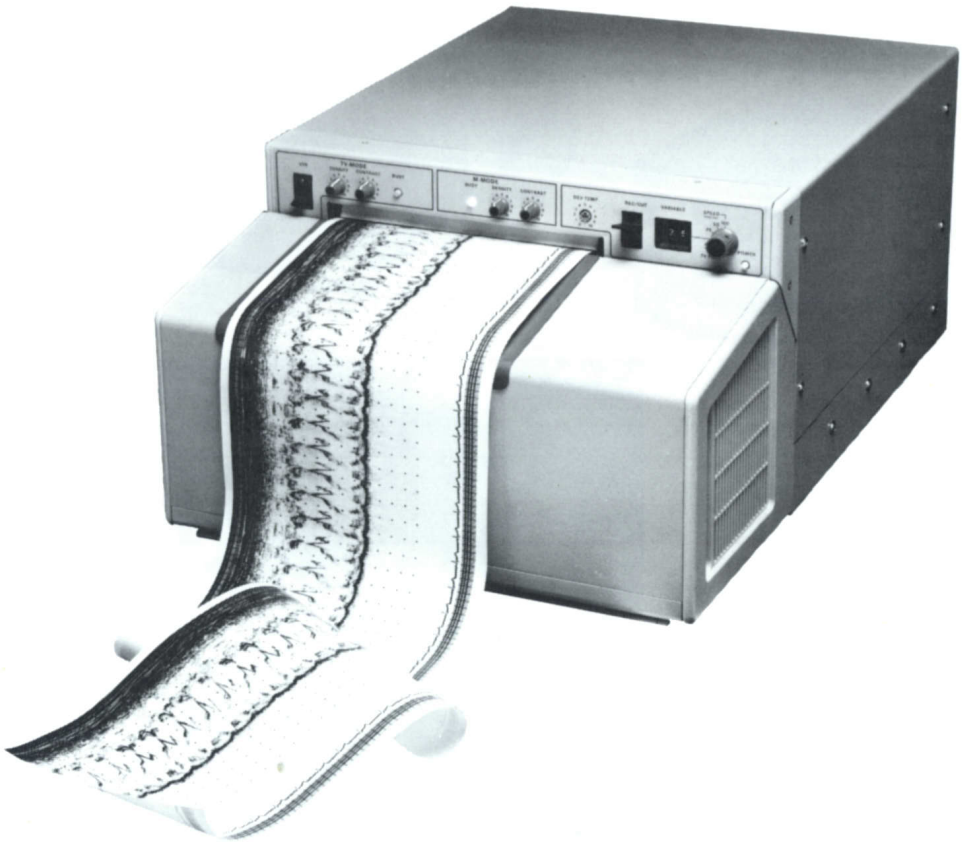
***WARRANTY-PLUS* SERVICE PLAN REFER TO PAGE 41**

N1 — Service Plan + 9 Months Service ..... **+$85**

OPTIONAL ACCESSORIES

Adaptor Card — 4012 Compatible
Order 018-0103-00 ..... **$90**

OEM terms available on these products.



4635 Imaging Recorder

Combined Line Scan/TV Imager

Superior Image Quality

Excellent Gray Scale and Resolution

Choice of Two Recording Media

Significant Savings in Paper Costs

Designed for Heavy Workload

Available Only to Qualified OEMs

The 4635 Imaging Recorder produces high-quality gray-scale images from both line scan and composite TV video sources. It is optimized for the requirements of diagnostic ultrasound, but can also be used for other applications requiring dual mode recording capability.

The 4635 records on two types of photographic Dry Silver Paper: a High-Performance Paper for applications demanding extended gray scale and a lower cost standard paper for limited gray-scale needs. The 4635 can withstand heavy usage demands, processing a minimum of 50 rolls of paper (25,000 feet) between planned maintenance.

Images produced by the 4635 are exposed using a CRT with a fiber-optic faceplate. Tiny fiber-optic filaments in the faceplate transmit the light output of the CRT to the paper.

Following exposure the paper is advanced through a thermal processor, where the latent image is developed. The fully processed image then exits the recorder through a front-panel opening.

The 4635's combination of superior imaging capability, rugged design, and low cost operation make it the standard for quality and value among imaging recorders.

CHARACTERISTICS

Recording Technique — Exposing photographic Dry Silver Paper with light output from a fiber-optic CRT (Cathode Ray Tube).

Developing Technique — Heating the Dry Silver Paper in an internal processor.

IMAGE SIZE

Line Scan — Width is adjustable from 100 mm to 200 mm.

TV, Horizontal — 60 Hz: 125 mm to 210 mm. 50 Hz: 150 mm to 210 mm.

TV, Vertical — Adjustable to provide correct aspect ratio.

IMAGE FORMATS

Line Scan — Successive lines written across width of paper, perpendicular to path of exiting paper, continuous recording.

Raster Scan TV — Raster lines written in direction of paper path. OEM can select either cut TV page or TV frame insertion into continuous line scan recording.

IMAGE

Density Range — High Performance Paper: Min 0.2, max 1.4. Standard Paper: 1.2.

Shades of Gray — TV Page: 12 levels for High Performance Paper, 8 levels for Standard Paper. Line Scan: 8 levels for High Performance Paper, 6 levels for Standard Paper.

Resolution — Four cycles per mm in line scan. Two cycles per mm in TV page.

RECORDING MEDIA

Material — Tektronix High Performance Dry Silver Paper or Tektronix Standard Dry Silver Paper.

Paper Packaging — Rolls of paper encased in light-sealed cylindrical cassettes.

Paper Roll Dimensions — 152 m (500 ft) long, 216 mm (8.5 in) wide.

Shelf Life (Unexposed) — Up to 14 months at 70°F (21°C) at 50% relative humidity. Up to 6 months at 100°F (38°C) with small variation in sensitivity. Shelf life is extended if paper is refrigerated.

PAPER SPEEDS

Lines Scan — 10 mm/s to 100 mm/s.
TV Page — 35 mm/s.

CONTINUOUS LINE SCAN OPERATION X-AXIS

Slew Rate Range — 50 ms to 500 ms.

Retrace Time — 30 ms or less.

Repetition Rate — 750 Hz to 3 kHz.

Amplitude — 6 V ±0.5 V.

Offset — Some portion must be at zero volts.

CONTINUOUS LINE SCAN OPERATION Z-AXIS

Amplitude — 5 V ±1 V for entire modulation range.

Offset — ±1 V dc.

RASTER SCAN TV OPERATION

Line Rate — 15.4 kHz to 16.0 kHz.

Field Rate — 50 Hz to 60 Hz.

POWER SPECIFICATIONS

Voltage Ranges (±10%) — 100 V ac, 115 V ac, 120 V ac, 200 V ac, 220 V ac, and 230 V ac or 240 V ac

Line Frequency — 48 Hz to 62 Hz.

Power Consumption — 800 W max peak power demand.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	425	16.8
Height	266	10.5
Depth	667	26.3
Weight ≈	**kg**	**lb**
Net	34.0	75.0

INCLUDED ACCESSORIES

500 ft roll high performance dry silver paper (006-2432-00).

ORDERING INFORMATION

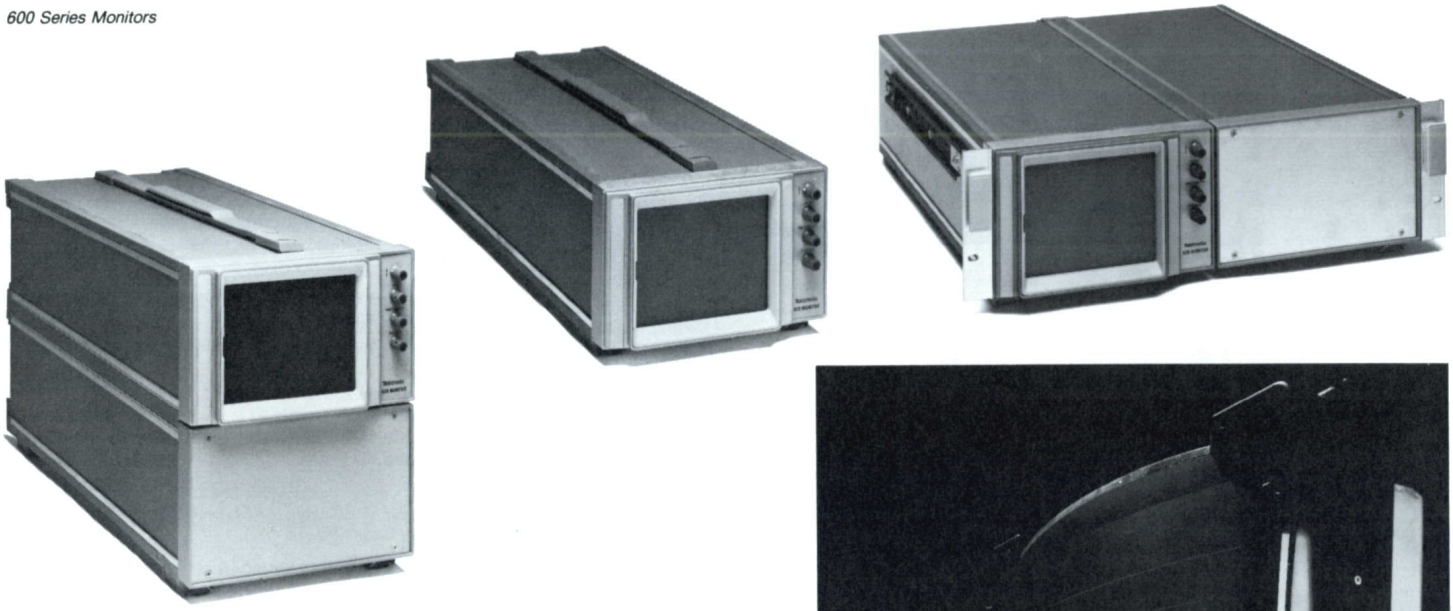
4635 Imaging Recorder

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

Available only to qualified OEM's.

600 Series Monitors



Product Summary

Support

Reliability

Performance

Value

When you deal with Tektronix, you are dealing with a supplier who stands behind you every step of the way. As a world leader in display technology, we are committed to building lasting OEM relationships and supporting them with continuing new product developments.

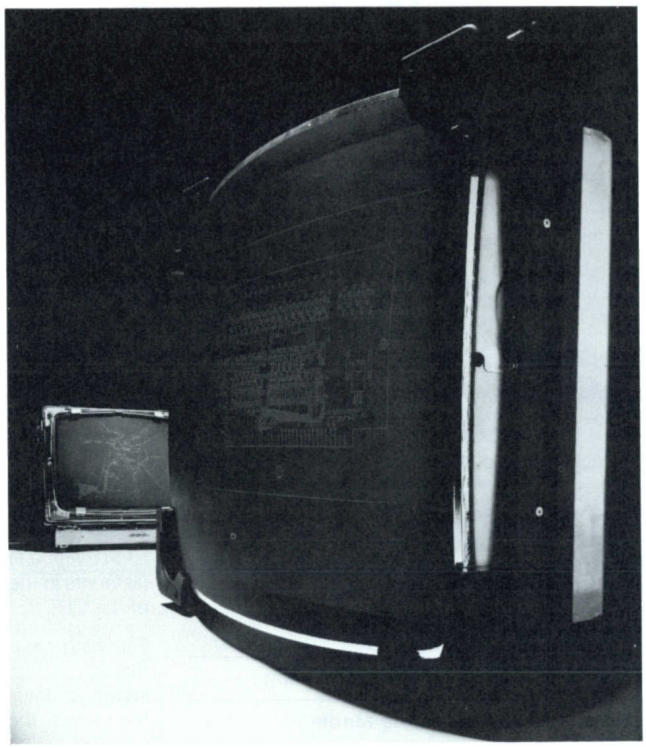
Your Tektronix resource starts with a broad and comprehensive package of OEM support including: OEM service agreements and capabilities throughout the United States and in many countries; interface assistance and applications engineering, custom mods and documentation; and OEM pricing, terms, and conditions, to help make you competitive.

At Tektronix, our product reliability is your foundation. Your systems can only be as reliable as the components that go into them. Tektronix is committed to producing the most dependable products possible. You can be confident that the reliability we engineer into every product will help keep your customers satisfied and your service costs down.

Consider the advantages of working with us: product performance with built-in reliability and measureable value, in addition to extensive OEM service and support. Your local Tektronix OEM Representative will show you how you can profit from a partnership with Tektronix.

600 Series Products

600 series monitors are proven performers in diverse applications ranging from medical imaging to military systems.



GMA Series Displays

Tektronix pioneered the use of Cathode Ray Tubes in oscilloscopes over 35 years ago. With years of expertise in display design, TEK now offers display monitors for other applications requiring crisp, high resolution presentation of waveform or image data.

The five basic models are available to meet your needs: 606B, 608/620/624 and 634. The 606B offers high resolution X-Y for SEM's, Gamma cameras, and medical multi-imaging. 608/624 monitors meet the requirements for medical imaging and other demanding applications with high brightness X-Y and crisp displays. The rugged 620 has reliable X-Y for the demands of military systems and instrumentation uses. The high resolution 634 video monitor offers unparalleled performance for medical imaging, computer graphics cameras, and military systems.

The standard displays come without handle, feet and covers. Options are available for each product to add these and other features you may require to meet your application. Contact your local Tektronix representative to discuss your application and selecting the display to meet your needs.

For information on compatible cameras see camera section.
For information on compatible hard copy units, refer to page 133.

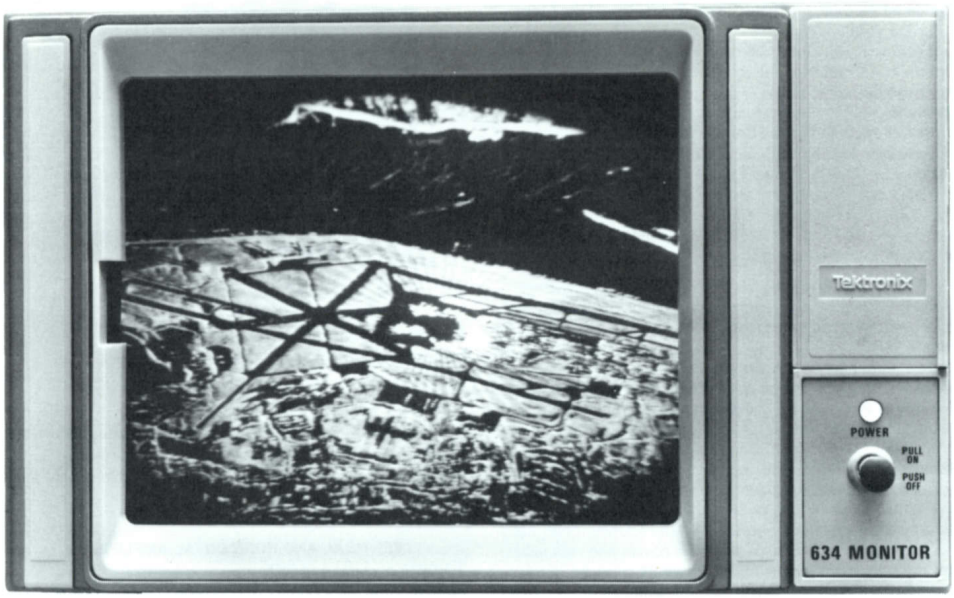
GMA Series Display Modules

GMA series display modules are built specifically for the system builder. We're committed to keeping the finest graphics display capabilities in the world available for you. Graphics that will fit your system perfectly and your customer needs precisely.

The GMA series consists of the 19 inch storage GMA 102A and 19 inch color-enhanced-refresh storage GMA 103, and also the 25 inch GMA 125 storage display. All offer storage with refresh technology which permits real-time motion, rotation, scaling, and selective erase.

The GMA's chassis construction enables easy integration with the rest of your system and facilitates rapid service. Proven compatibility slashes your design turn around time, enabling early market entry and greater market share opportunities.

SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.



634 Monitor

Extremely High Resolution, Low Distortion Display for Demanding Applications

The 634 Video Display monitor delivers extremely high quality video images for both viewing and photography. Applications include: medical diagnostic imaging, military infrared imaging, and automated test systems.

Tektronix' distortion requirements surpass normal standards. With the 634, you'll have less than 1/2 percent distortion inside a 90 mm circular area; less than one percent for the rest of the screen. The 634 has a flat faceplate that preserves geometric accuracy in viewing and photographic applications. Dynamic focusing assures crisp images, even in the corners.

Resolution on video displays can be separated into two catagories: vertical and horizontal. Vertical resolution is limited by the video line rate used. At the RS-170 rate of 525/60, approximately 480 lines are visible. Option 15 extends the 634 line rate to 1083/60, and improves the vertical resolution. Determined by spot size and video bandwidth, horizontal resolution typically exceeds 1400 lines per screen height at center screen. Option 14 increases video bandwidth to 20 MHz.

Excellent Gray Scale and Brightness Uniformity

The 634's CRT is designed to faithfully display gray scale images. This CRT utilizes an advanced gun design for excellent brightness uniformity (variation is less than ±10 percent across the screen).

The 634 may be operated on either ac or dc power. Ac power is standard; Option 20 configures the unit for dc power.

CHARACTERISTICS

DISPLAY

Type — Raster scan, monochrome CRT.

Dimensions — 90 mm x 120 mm (3.5 in x 4.7 in), 15 cm (5.9 in) diagonal.

Aspect Ratio — 4 x 3.

Resolution (Measured using the shrinking raster method, no interlace) — Center Screen at 100 cd/m² (30 fL): 1400 lines nominal (1100 lines worst case) or 800 lines nominal (650 lines worst case) with Option 01.

Position Accuracy — ≤0.5% within 90 mm circle (≤1% with Option 01). ≤1% outside 90 mm circle (≤2% with Option 01).

Brightness — 515 cd/m² (150 fL) max.

Brightness Uniformity (Using J16 Photometer) — Better than ±10% over the scan area.

Phosphor Type — WB (P45).

LINE/FIELD RATE

Standard — 525/60 (adjustable to 625/50).

Option 15 — 1083/60, adjustable down to 675/60.

VIDEO INPUT

Signal — Composite video with negative sync; RS-170 compatible.

Signal Level — 0.35 V p-p to 2.0 V p-p.

Maximum Safe Input — 5.0 V p-p.

Bandwidth — 1 Hz to 10 MHz (20 MHz with Option 14).

Impedance — 75 Ω loop through; switchable 75 Ω termination.

Return Loss — 46 dB to 5 MHz with or without internal 75 Ω termination and power on.

Dc Restoration — Referenced to back porch or sync tip.

External Sync — Switchable.

SAFETY

Department of D.H.H.S. (BRH Rule 1020 10 (C) (1) standard. UL 544 Listing (Option 06) and UL 544 Component Recognition (Option 09). C.S.A. certified.

AC POWER

Voltage Ranges (±10%) — 100 V ac, 110 V ac, 120 V ac, 200 V ac, 220 V ac, and 240 V ac.

Line Frequency — 48 Hz to 440 Hz.

Power — 50 W at 120 V ac, 60 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	214	8.4
Height	133	5.2
Height (Option 06)	160	6.3
Depth	423	16.7
Depth (Option 20)	367	14.4
Weight	**kg**	**lb**
Net	6.3	13.8
Net (Option 20)	4.6	10.1

INCLUDED ACCESSORIES

CRT implosion shield (337-2537-01); CRT filter (378-0133-00); instruction manual; operator's manual.

ORDERING INFORMATION

634 Monitor
(without handle, feet and covers) **$2,900**

Option 01 — Resolution of 800 Lines Nom, 650 Lines Worst Case. Position Accuracy — 1% in 90 mm Circle, 2% Rest of Screen ..... **−$205**

Option 06 — UL 544 Listing (covers, handle and feet included; not available with Option 20) ..... **+$100**

Option 09 — UL 544 Component Recognition ..... **NC**

Option 13 — Video Reverse ..... **+$85**

Option 14 — 20 MHz Video Amplifier ..... **+$145**

Option 15 — High Line Rate. Factory Calibrated at 1083/60. User Changeable to Rates Between 675/60 and 1083/60 with Supplied Parts Kit ..... **+$280**

Option 16 — Provides a 25 Pin Connector for Video Input, External Sync, TTL Z-axis Blanking, and External Brightness, Contrast, and Focus Controls (which are removed from the front and shipped separately) ..... **+$45**

Also Provides for a Video Reverse Input when Option 13 is Included.

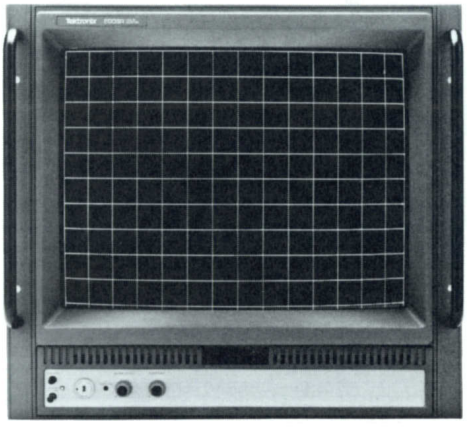
Option 20 — Dc Supply — +23 V, −22 V, +9 V (unregulated) ..... **−$235**

016-0402-00*1 — Rackmount Kit (one 634 and one empty cabinet side by side; not compatible with Option 20) **$345**

016-0403-00*1 — Rackmount Kit (two 634s side by side in 19 in rack; not compatible with Option 20) **$250**

**1 OEM pricing not available on rackmount kits. Quantity discount information is available on request.*

SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.



690SR

- High Resolution, 19 inch, RGB Color Display
- Delta Gun, Dot-Shadow Mask CRT
- Variable Scan Rates
- Adjustable Picture Size and Aspect Ratio
- Precise Color Convergence
- Plug-in Interface Modules
- Stabilized Color Balance
- Rugged Construction
- Recommended for Television Display or Computer Graphics

See page 185 for more information.

620

620 Monitor

General Purpose, Economical, X-Y Waveform Display

The 620 has Built-in Reliability
With fewer parts and lower power, display and system reliability are improved, and service costs are lower.

Package the 620 the Way You Want It
A wide variety of packaging options are available for easy integration into your system.

CHARACTERISTICS

DISPLAY

Type — Flat-faced rectangular CRT.
Dimensions — 100 mm x 120 mm (3.9 in x 4.7 in).
Phosphor — GH (P31) is standard.
Spot Size — 0.38 mm (15 mils) at 0.5 μA.
Linearity — The voltage required to produce a 25-mm deflection from any point on the CRT will not vary more than 5%.
Usable Brightness — Up to 100 cd/m² (30 fL).

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth — Dc to 2 MHz.
Settling Time — 1 μs from any point on the CRT within 0.5 mm of final position.
Deflection Factor — (Adjustable) Vertical: ≤0.9 V to ≥1.5 V/100 mm. Horizontal: ≤0.8 V to ≥1.2 V/100 mm.
Input R and C — 1 MΩ shunted by <47 pF.
X-Y Phase Difference — 1° max, dc to 500 Hz.
Max Input Voltage — ±25 V (dc plus peak ac).
Recommended Source Impedance — ≤10 kΩ.

Z-AXIS AMPLIFIER

Bandwidth — Dc to ≥5 MHz.
Input Sensitivity Range — Not adjustable. 1.0 V will produce maximum brightness with Intensity Control set at mid-range.

AC POWER

Voltage Ranges (±10%) — 100 V ac, 110 V ac, 120 V ac, 200 V ac, 220 V ac and 240 V ac.
Line Frequency — 48 Hz to 440 Hz.
Power — 22 W at 120 V ac.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Height (without feet)	133	5.2
Width	214	8.4
Depth	500	19.7
Weight (without handle, feet, and covers)	**kg**	**lb**
Net	5.3	11.7
Shipping	6.9	15.2

INCLUDED ACCESSORIES

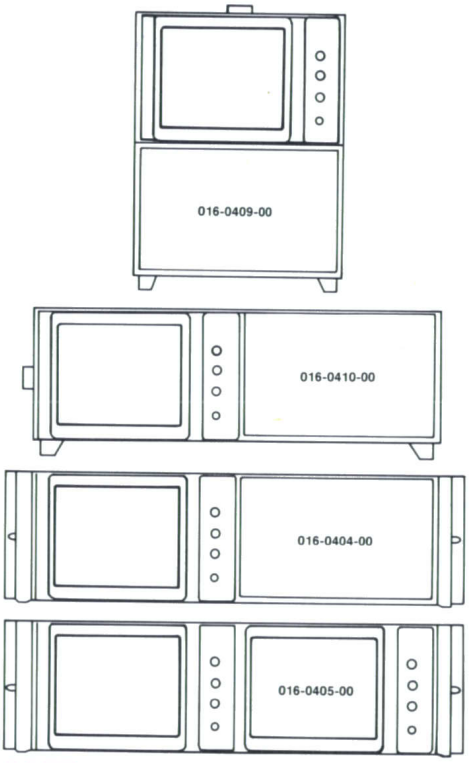
CRT graticule (331-0455-00); instruction manual; operator's manual.

ORDERING INFORMATION

620 Monitor
(without handle, feet or covers) **$1,400**
Option 01 — Internal Graticule
(8 x 10 div at 12.2 mm/div) ..... **NC**
Option 06 — UL 544 Listed
(includes handle, feet, and covers) ..... **+$100**
Option 09 — UL Component Recognition
(not compatible with Option 06) ..... **NC**
Option 10 — Remote 25-pin Program Connector, X, Y, Z-axes, Single-ended Inputs Only
(not available with Option 31) ..... **+$50**
Option 20 — Delete ac power. External dc Power Required (17 to 26 V, at 0.9 A),
(not available with Option 06 or 31) ..... **−$25**
Option 23 — Handle, Feet and Covers,
(not available with Options 06, 28, or 31) ..... **+$80**
Option 25 — TTL Blanking ..... **+$50**
Option 28 — With Covers Only — No Trim Strips
(not available with Options 06, 23, or 31) ..... **+$70**
Option 31 — Delete all Rear Panel BNCs, dc Power Connector and ac Power Supply and Switch. Provision for External dc Power (+17 V unregulated) is Provided. (not compatible with Options 06, 10, 20, 23 and 28). Can be Used with 016-0409-00 or 016-0410-00 Packaging ..... **−$25**

PACKAGING FOR THE 620

Modular Packaging allows you to combine the 620 Display with your own custom electronic circuitry in an adjacent compartment.
Vertical Package — Includes empty compartment, connecting hardware, handle, feet and covers. Order 016-0409-00 . **$275**
Horizontal Package — Includes empty compartment, connecting hardware, handle, feet and covers.
Order 016-0410-00 ..... **$255**
Rackmounting — Includes empty compartment, frame, covers, and rack slides for mounting in a 19-inch rack. Not available with Options 06, 23, or 28. Order 016-0404-00 ..... **$330**
Side-by-Side 620 Rackmounting — To rackmount two 620s side by side in a 19-inch rack. Includes covers and rack slides. Not available with options 06, 23, 28, or 31.
Order 016-0405-00 ..... **$235**



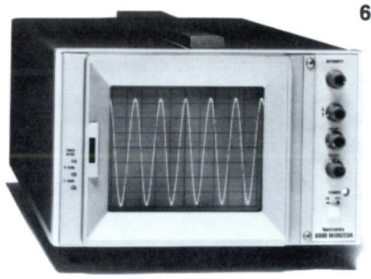
606B Monitor

Very High Resolution X-Y Display for Applications Requiring the Most Critically Sharp Photographs and Displays

The 606B offers image stability, gray-scale performance, and uniform brightness, critical to the quality of measurement or the accuracy of a medical diagnosis.

Uniform resolution and variable spot size are also provided by the 606B. The 606B's metal bezel is a solid mount for heavy cameras and prevents light leaks or distortion.

606B



CHARACTERISTICS

DISPLAY

Type — Flat-faced rectangular CRT.
Dimensions — 80 mm x 100 mm (3.2 in x 3.9 in).
Display Linearity — 1% of full scale along major axes.
Spot Size — 0.079 mm (3.1 mils) or less.
Spot Growth — Not >20% at constant intensity within the quality area (70 mm x 90 mm).
Brightness Uniformity — <10% variation within quality area (70 mm x 90 mm).
Phosphor — GH (P31) is standard.

VERTICAL AND HORIZONTAL AMPLIFIERS

Risetime — 116 ns or less.
Settling Time — <500 ns with deflection-input attenuation in 1X position.
Bandwidth — Dc to at least 3 MHz (−3 dB).
Input — Differential; BNC connectors.
Deflection Factor (Vertical and Horizontal) — Adjustable, 0.5 V to 2.5 V for 80 mm deflection.
Input Impedance — 1 MΩ or 50 Ω ±1%, paralleled by <47 pF; internally selectable.
X-Y Phase Difference — Not more than 1° to at least 500 kHz.
Max Input Voltage — 1 MΩ Z_{in}: ±100 V (dc peak ac). 50 Ω Z_{in}: ±5 V (dc peak ac).

Z-AXIS AMPLIFIER

Input — Differential; BNC connectors.
Bandwidth — Dc to 5 MHz (−3 dB).
Risetime — ≤35 ns.
Sensitivity Range — Adjustable from 0 V to 1 V to 0 V to 5 V for full intensity control.

AC POWER

Voltage Ranges (±10%) — 100 V ac, 110 V ac, 120 V ac, 200 V ac, 220 V ac, and 240 V ac.
Line Frequency — 48 Hz to 440 Hz.
Power — 50 W nom; 75 W max at 120 V ac.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Height	133	5.2
Width	213	8.4
Depth	519	20.4
Weight ≈	**kg**	**lb**
Net	7.9	17.5
Shipping	10.3	22.7

INCLUDED ACCESSORIES

25-pin connector (131-0570-00); 25-pin connector housing (200-0821-00); CRT graticule (337-1674-10); power cord (161-0123-00); service manual; operator's manual.

ORDERING INFORMATION

606B Monitor
(without handle, feet or covers) **$4,450**
Option 06 — UL 544 Listing
(includes handle, feet, and covers) ..... **+$100**
Option 07 — Front-Panel Controls
Changed to Screwdriver Adjustments ..... **+$30**
Option 09 — UL 544 Component Recognized ..... **NC**
Option 28 — With covers (not available with Option 06) **+$70**
Rackmount Kits — Same as 608 and 624 on next page

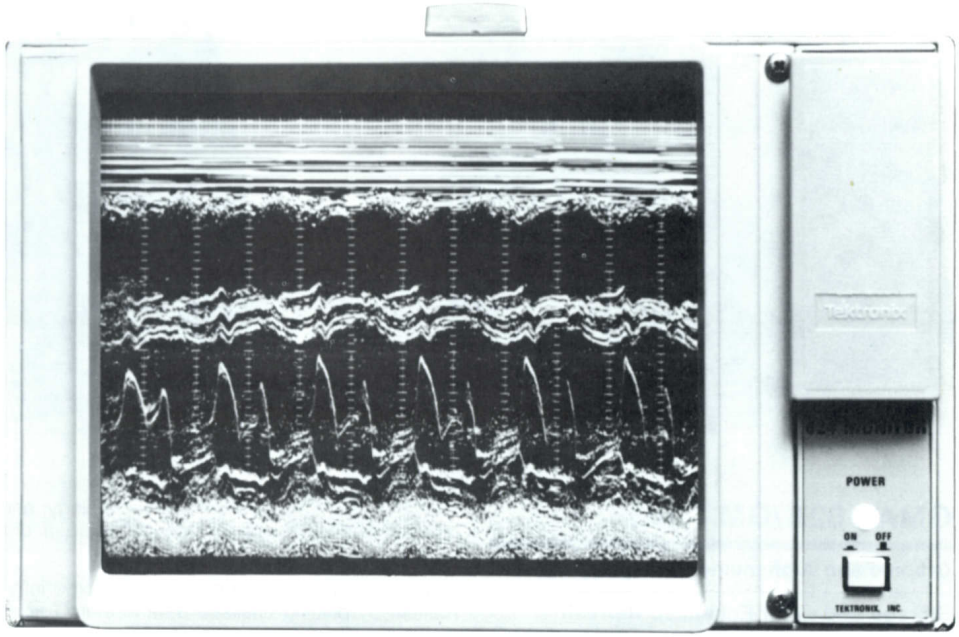
SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.

608 and 624 Monitors

High Resolution with Ambient-Light Viewing

Expansion-Mesh-Halo Suppression

Excellent Gray Scale, High Brightness Display



The 608 is Tektronix' finest directed-beam viewing monitor. It is extremely well suited for high-performance display applications such as medical and military imaging and electronic instrumentation. The 608's high usable brightness, small spot size, and large screen give excellent direct-viewing capability. When such clarity or brightness is not required, the comparable 624 is recommended. Both the 608 and 624 produce detailed displays that are easy to read in high ambient light and produce quality photographs.

Special CRT design suppresses expansion-mesh halo, which ordinarily causes lower contrast and a "washed out" appearance that interferes with high-brightness gray-scale displays. Expansion-mesh-halo suppression results in a more readable display with subtle and accurate gray-scale images and detailed waveforms. In addition, imaging is critically sharp from corner to corner, particularly on the 608, which uses dynamic focusing.

The wide deflection factor facilitates integration with a broad range of designs. An optional metal bezel lets you use heavy cameras, including those with motorized roll-film backs, without causing distortion, defocus, or light leaks.

In addition, optional full-differential inputs help reject unwanted common-mode signals such as ground noise and power-supply hum. Plus, the 608 can be ordered with gamma-correction for photographic applications. This option produces linear light-output changes with a linear change of Z-axis input, typically within 20 percent.

CHARACTERISTICS

DISPLAY

Type — Flat-faced, electrostatic CRT.

Dimensions — 98 mm x 122 mm (3.9 in x 4.8 in).

Phosphor — GH (P31) is standard.

Spot Size

608: 0.25 mm (10 mils) at 170 cd/m² (50 fL); max brightness −240 cd/m² (75 fL).

624: 0.3 mm (12 mils) at 170 cd/m² (50 fL).

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth

608: Dc to at least 5 MHz.

624: Dc to at least 3 MHz.

Deflection Factor — Adjustable 50 mV/div to 0.25 V/div. Option 22 (5X attenuator) extends deflection factor to 1.25 V/div.

Input R and C

608: 1 MΩ paralleled by <60 pF.

624: 1 MΩ paralleled by <47 pF.

X-Y Phase Difference

608: One degree max to at least 1.5 MHz.

624: One degree max to at least 1.0 MHz.

Maximum Input Voltage — ±100 V (dc plus peak ac).

Linear Common-Mode Signal Range (with Option 21) — ±3 V. (Option 22 extends range to ±15 V.)

Recommended Source Impedance — ≤10 kΩ.

Z-AXIS AMPLIFIER

Z-Axis amplifier permits intensity modulation of the writing beam.

Bandwidth

608: Dc to 10 MHz over usable range.

624: Dc to 5 MHz over usable range.

Sensitivity range is adjustable from 0 to +1 V to 0 to +5 V for full-intensity control.

Input R and C

608: 1 MΩ ±1% and <60 pF.

624: 1 MΩ ±1% and <47 pF.

Linear Common-Mode Signal Range (with Option 21) — ±5 V.

AC POWER

Voltage Ranges (±10%) — 100 V ac, 110 V ac, 120 V ac, 200 V ac, 220 V ac, and 240 V ac.

Line Frequency — 48 Hz to 440 Hz.

Power — 61 W max at 120 V ac.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Height (without feet)	213	8.4
Width	133	5.2
Depth	493	19.4
Weight*	**kg**	**lb**
Net	8.0	17.6
Shipping	10.4	23.0

INCLUDED ACCESSORIES

CRT graticule (337-2126-02); instruction manual; operator's manual.

ORDERING INFORMATION

608 Monitor
(without handle, feet, or covers) **$2,690**

624 Monitor
(without handle, feet, or covers) **$2,740**

Option 01 — Internal Graticule ..... **NC**
Option 09 — UL 544 Component Recognition ..... **NC**
Option 10 — 25-pin Remote Program Connector
X, Y, and Z, Single-ended Inputs ..... **+$50**
Option 20 — Without ac Supply (±18 V Unregulated dc Supply Required) (624 only) ..... **−$30**
Option 21 — Full Differential Inputs (X,Y,Z) ..... **+$50**
Option 22 — Extended Gain Range 5X Attenuator ..... **+$35**
Option 23 — Handle, Feet, and Covers
(Not Available with Option 28) ..... **+$80**
Option 24 — Linearized Z-Axis (Gamma Correction)
(608 only) ..... **+$75**
Option 25 — TTL Blanking ..... **+$75**
Option 28 — Covers Only
(Not Available with Option 23) ..... **+$70**
Option 29 — Metal Bezel ..... **+$70**

OPTIONAL ACCESSORIES

RACKMOUNTING FOR 606B, 608, 624

Rackmount and Empty Cabinet Kit — Slide-out 19 in rack assembly which mounts a display monitor and an empty compartment horizontally. In the compartment you may put your custom electronic circuitry and connect it to the display, all in one enclosure Order 040-0601-00 ..... **$335**

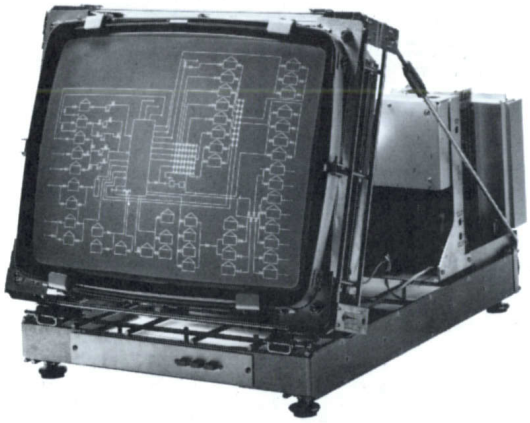
Display/Power Module Kit — Allows rackmounting of 606B, 608, and 624 with TM 503 Power Module. Minimizes mechanical design time. Simply design your own electronics using TM 500 Custom Plug-in kits described on page 406. Then plug them in. Fits standard 19 in rack. Order 040-0624-01 ... **$120**

Rackmounting Kit for 606B, 608, and 624 — Slide-out 19 in rack assembly which rackmounts any two of the above displays side by side. Includes covers and rack slides.
Order 040-0600-00 ..... **$200**

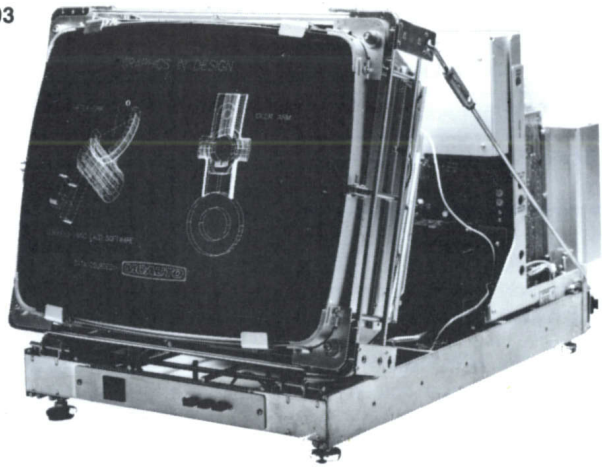
Rackmount-to-Cabinet Conversion — Required to convert a rackmount 606B, 608 or 624 to a cabinet style.
Order 040-0602-00 ..... **$160**

SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFY OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.

GMA102A



GMA103



GMA 102A/GMA 103

Graphic and Alphanumeric Display

Storage and Color Enhanced Refresh

Modular Construction, 19-inch, High Performance Display for Systems Builders

The GMA 102A can display up to 40 vector meters 1575 vector inches, 30 Hz refresh rate of refresh data while simultaneously having all of the benefits of storage technology. The storage mode presents high resolution, high density graphics at low cost, while the refresh feature adds the benefits of selective erase, interactivity and dynamic motion with the same high resolution of storage. By placing fixed or finalized data in store while retaining dynamic or working data in refresh, you can achieve high density, interactive graphics while making maximum use of your computer to address the application task rather than support the display.

Operation

All display functions are completely programmable and designed to interface to TTL logic. They are Write-Thru, Non-Store, Brite, Defocus, Center, Copy, Erase, View and G Busy.

Options Addressed to the OEM

The GMA 102A is driven as a X-Y directed beam display using analog inputs. It has a clear glass filter and is compatible with Tektronix hard copy units. The display can be supplied with the CRT module tilted as far back as 15 degree or oriented in either the horizontal or vertical (page) format. Space has been left in the card cage for you to add up to three circuit boards with your application options. Additionally, our Option 43 Vector/Character Generator can be plugged into two of these positions to give you a completely digital interface (16-bit word format plus control and status signals).

At your option, you can use your interface connector or ask for our Option 34 (analog) or Option 35 (digital) connector.

GMA 103 is a high performance member of the GMA display product family. Its storage mode provides high resolution, high density graphics at a low cost. Color and refresh add increased viewability, selective erase, interactivity, and dynamic motion with the same high resolution. GMA Family features include modular construction, a blending of storage and refresh technology, and interface/packaging options to configure a display for user applications.

Quick differentiation of working and stored information. By placing finalized data in store (green display) while retaining working data in refresh (yellow-orange display), you can achieve high density, graphics while using your computer to address other tasks. Working files are easily distinguished from fixed or stored files.

Modular Construction

The CRT, low voltage power supply and printed circuit board modules are arranged on a unique high-strength wireform chassis. This construction not only supports different performance, interface, and packaging options but permits easy removal of modules for field service.

Operations

All display functions are completely programmable and designed to interface to TTL logic. The GMA103 is completely compatible with other members of the GMA family. If refresh is already being used in a GMA family display, no new signals are required to support color refresh.

A CRT anti-burn circuit is provided to protect against burning the CRT phosphor in the event that X and Y deflection is not commanded to move or is lost with the writing beam on. In addition, the screen is automatically erased after 30 minutes from the last Z-Axis or G-Busy pulse or View initiate.

The 618 and 614 are similar to the GMA 102A and 103, respectively and are housed in an attractive cabinet enclosure. Refer to page 126 for more information.

CHARACTERISTICS

DISPLAY

CRT Type — Directed beam, direct view storage CRT.

Dimensions — 48 cm (19 in) diagonal.

Addressable Area — 267 mm x 356 mm (10.5 in x 14 in).

Stored Resolution — 16 lines/cm (40 lines/in) center screen; 14 lines/cm (35 lines/in) at screen periphery.

Stored Dot Writing Time — 5 μs or less.

Stored Vector Writing Rate — 150 m/s (5900 in/s).

Vector Writing Rate — Refresh: 1200 m/s (47,240 in/s), (write-thru and nonstore); 40 vector meters (1575 vector in) max at 30 frames/s.

Viewing Time — At least 15 minutes at specified resolution.

Erase Time — 1.5 s ±20%.

DEFLECTION AMPLIFIERS

X-Y Input — Differential analog.

Origin (X=0, Y=0 Volts) — Center screen.

Input Sensitivity — Long Axis: 10 V p-p full screen ±2.5%. Short Axis: 7.5 V p-p full screen ±2.5% of long axis.

Maximum Input Voltage — ±6.5 V (dc + peak ac).

Input Impedance — 10 kΩ ±10%. paralleled by <100 pF.

Slew Rate (Nonlinear Operation) — 5000 m/s.

Settling Time (Nonlinear Operation) — 1 μs + 2 μs/cm to within one spot diameter for vector lengths >1 cm; 3 μs to within one spot diameter for vector lengths of 1 cm or less.

Positional Accuracy — All points within the CRT addressable area are addressable with an accuracy of ±1.25% of the long axis dimension.

Z-AXIS

Input Requirements — TTL compatible. LO True. (Strap selectable to HI True).

Risetime — 70 ns, limited to 1 MHz continuous repetition rate.

Input Impedance — 50 Ω (Strap selectable to 75 Ω or 93 Ω).

Status Signal — D Busy, SLU (HCU available when an appropriate hard copy device is connected).

AC POWER

Voltage Range — 90 V ac to 110 V ac, 108 V ac to 132 V ac, 198 V ac to 242 V ac or 216 V ac to 264 V ac (jumper selectable).

Line Frequency — 48 Hz to 66 Hz.

Power — 315 W max at 115 V ac.

PHYSICAL CHARACTERISTICS*1

Dimensions	mm	in
Width	487	19.2
Height	461	18.2
Depth	705	27.8
Weight	**kg**	**lb**
Net	45.0	100.0
Shipping	56.7	125.0

*1 *Horizontal Format (no tilt).*

INCLUDED ACCESSORIES

Instruction manual.

ORDERING INFORMATION

GMA 102A Computer Display Module

GMA103 Computer Display Module

Option 33 — Front Panel Pushbuttons

Option 34 — Analog Rear Connector

Option 35 — Digital Rear Connector

Option 37 — Green Glass CRT filter (GMA 102A only)

Option 38 — Blue Glass CRT filter (GMA102A only)

Option 43 — High Speed Vector/Dot Character Generator

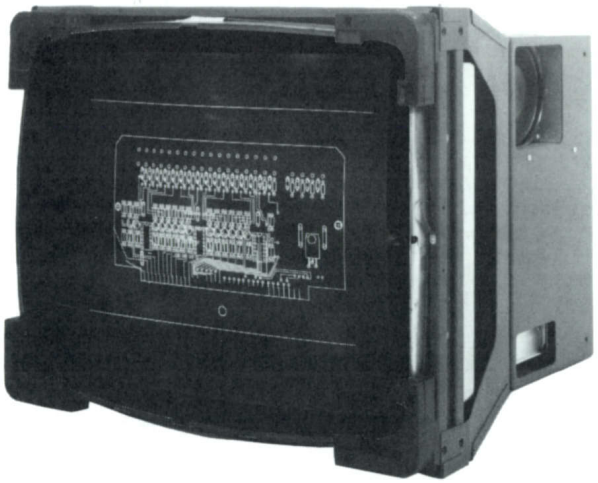
OPTIONAL ACCESSORIES

Screw Adjust Feet Order 020-0245-00

Breadboard Kit Order 020-0269-00

Tektronix offers service training classes on the GMA 102A/103. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.

Available only to qualified OEM's.



GMA 125

Combined Storage and Write Thru

25 inch Diagonal CRT

The GMA 125 was designed exclusively for systems builders, and is intended to satisfy display applications of the greatest size and complexity. It incorporates 65 percent more workspace than the 483 mm (19 in) GMA 102A. Like other members of the GMA series, it provides low cost, high resolution, storage tube graphics and unique flexibility of performance, interfacing and packaging.

Further, the GMA 125 offers that same powerful combination of simultaneous storage and refreshed displays that was first provided in the GMA 102A.

The Detail of Storage. The Dynamics of Refresh.
The GMA 125 features a 635 mm (25 in) CRT that offers unequaled information display capacity. Adjacent points that would be indistinguishable on a smaller screen can be seen as distinct units on the GMA 125. It is ideal for group viewing and for greater graphics detail. A unique 110° CRT provides greater display brightness with less energy consumption in a more compact package.

The GMA 125 will display up to 50 vector meters (1968 vector inches) of refreshed data, enabling all the benefits of selective erase, interactivity and dynamic motion with the same high resolution of storage.

By placing fixed or finalized data in store while retaining dynamic or working data in refresh, you can work interactively with high density graphics and alphanumerics while making maximum use of processing power to address the application rather than support the display.

Modular Design Assures Ideal Building Economy
Order CRT, chassis and power supply only, or configure your GMA 125 to best fit your own manufacturing capabilities and system specifications. The welded-steel, symmetrically structured chassis may be rotated vertically or horizontally, and tilted. Space is left in the card cage for your own application options. Or you can plug in our Option 43 Vector/Character Generator to provide you with a completely digital interface (16 bit word format plus control and status signals). You can use your interface connector or our analog or digital interface options.

Colored light filters and several other support options are also available.

Operation
The standard display instrument is driven as an X-Y directed beam display using analog inputs. The CRT beam is positioned at center screen with zero volts applied. All other display functions are completely programmable and designed to interface to TTL logic. The display functions are Write-Thru, Non-Store, Brite, Defocus, Center, Copy, Erase, View and G Busy. The Z-axis input is a digital signal.

The 616 Monitor is similar to the GMA 125 and is housed in an attractive cabinet enclosure. Refer to page 126 for more information.

CHARACTERISTICS

DISPLAY

CRT Type — Direct beam, direct view storage CRT.

Dimensions — 60 cm (24 in) diagonal.

Quality Area — 490 mm x 362 mm (19.3 in x 14.25 in).

Addressable Area — 457 mm x 343 mm (18 in x 13.5 in).

Visual Resolution — Center Screen: 16 lines/cm (40 lines/in). At Screen Periphery: 14 lines/cm (35 lines/in).

Stored Dot Writing Time — 2 μs or less.

Vector Writing Rate — Stored: 200 m/s (7800 in/s). Refresh: 1500 m/s (59,055 in/s) write-thru and nonstore, 50 vector meters (1968 in) max at 30 frames/s.

Viewing Time (At Specified Resolution) — At least 15 min.

Erase Time — 1.0 s ±12%.

AC POWER

Voltage Ranges are 90 V ac to 132 V ac and 180 V ac to 250 V ac at 48 Hz to 440 V ac. Power dissipation is 350 W max (420 W max for Option 36).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	610	24.0
Height	478	18.8
Depth	531	20.9
Weights	**kg**	**lb**
Net	47.9	105.6
Shipping	66.0	145.5

INCLUDED ACCESSORIES

Operator's manual.

ORDERING INFORMATION

GMA 125 Display Module

Option 30 — Non-Hard Copy Compatible

Option 34 — Analog Rear Panel Connector

Option 35 — Digital Rear Panel Connector

Option 36 — Additional Cooling Fan

Option 38 — Blue Glass CRT Filter

Option 43 — High-Speed Vector/Dot Generator

OPTIONAL ACCESSORIES

Breadboard Kit — Order 020-0269-00

Tektronix offers service training classes on the GMA Computer Display Module Series. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

INTRODUCTION

Now you can rely on Tektronix as your single supply source for all media, pens and ink for your Tektronix copiers, plotters, printers and storage devices. By using Tektronix-brand supplies, you can be assured of getting the best output quality of your Tek peripherals.

For further information, or to order any of the Tektronix-brand supplies listed below, call your local Tektronix Sales Office.

INK-JET SUPPLIES

4691 Ink Cartridges
200 ml Each

Cyan	016-0713-00	$85
Black	016-0714-00	$85
Yellow	016-0715-00	$85
Magenta	016-0716-00	$85

4691 Ink Jet Copy Paper
500 Sheets Per Package

216 x 279 mm (8.5 x 11 in)A Size	016-0712-00	$25
279 x 432 mm (11 x 17 in)B Size	016-0711-00	$40

297 x 210 mm (only for use with 4691 Option 01)

A4 Size	016-0709-00	$20

297 x 420 mm (only for use with 4691 Option 01)

A3 Size	016-0710-00	$35

4691 Transparency Film
100 Sheets Per Package

A Size	016-0765-00	$85
A4 Size	016-0766-00	$75

4691 Drum Adaptors

Package of 3	118-2593-00	$15

4695 Ink Cartridge Packages
2.5 cc Each, 16 per package

Yellow	016-0734-00	$25
Magenta	016-0735-00	$25
Cyan	016-0736-00	$25
Black	016-0737-00	$25

4695 Ink Jet Copy Paper
50 m Each 6 Rolls Per Box

Roll Paper	016-0743-00	$50

4695 Ink Jet Copy Paper
500 Sheets Per Package

A Size	016-0739-00	$25
A4 Size	016-0740-00	$22

4695 Transparency Film

100 Sheets Per Package	016-0480-00	$85

Liquids

Maintenance Liquid (200 cc)	016-0732-00	$10
Print Head Protect Liquid (10 cc)	016-0733-00	$4.00

PLOTTER PENS

4663, 4662 Option 31

Presentation Pack	020-0888-00	$60

4663, 4662 Option 31 Paper Pens
Regular Width
Individual Colors Available in 3-Pen Packs.

Black	016-0414-00	$8.00
Brown	016-0414-01	$8.00
Red	016-0414-02	$8.00
Orange	016-0414-03	$8.00
Yellow	016-0414-04	$8.00
Green	016-0414-05	$8.00
Blue	016-0414-06	$8.00
Purple	016-0414-07	$8.00
Magenta	016-0414-08	$8.00
9-Pen Multicolor Pack	016-0414-09	$24

4663, 4662 Option 31 Paper Pens
Fine Line
Individual Colors Available in 3-Pen Packs

Black	016-0725-00	$12
Brown	016-0725-01	$12
Red	016-0725-02	$12
Orange	016-0725-03	$12
Yellow	016-0725-04	$12
Green	016-0725-05	$12
Blue	016-0725-06	$12
Purple	016-0725-07	$12
Magenta	016-0725-08	$12
9-Pen Multicolor Pack	016-0725-09	$36

4663, 4662 Option 31 Transparency Pens
Individual Colors Available in 3-Pen Packs

Black	016-0469-00	$10
Brown	016-0469-01	$10
Red	016-0469-02	$10
Orange	016-0469-03	$10
Yellow	016-0469-04	$10
Green	016-0469-05	$10
Blue	016-0469-06	$10
Purple	016-0469-07	$10
Magenta	016-0469-08	$10
9-Pen Multicolor Pack	016-0469-09	$25

4663, 4662 Option 31 Wet Ink Pens

0.3 mm (0.01 in) Dia Tip Pen Body	016-0444-01	$23
0.5 mm (0.02 in) Dia Tip Pen Body	016-0442-01	$23
0.8 mm (0.03 in) Dia Tip Pen Body	016-0443-01	$23

Replacement Tips

0.3 mm (0.01 in) Dia Tip	214-2706-00	$20
0.5 mm (0.02 in) Dia Tip	214-2706-01	$20
0.8 mm (0.03 in) India Tip	214-2706-02	$20

4662 Paper Pens Standard 1-Pen Unit
Individual Colors Available in 3-Pen Packages

Red	016-0589-00	$8.00
Green	016-0589-01	$8.00
Black	016-0589-02	$8.00
Blue	016-0589-03	$8.00

4662 Transparency Pens (Standard 1-Pen Unit)
Individual Colors are Available in 3-Pen Packages

Black	016-0648-00	$8.00
Brown	016-0648-01	$8.00
Red	016-0648-02	$8.00
Orange	016-0648-03	$8.00
Yellow	016-0648-04	$8.00
Green	016-0648-05	$8.00
Blue	016-0648-06	$8.00
Purple	016-0648-07	$8.00
Magneta	016-0648-08	$8.00

4662 Wet Ink Pens (Standard 1-Pen Unit)

0.35 mm (0.014 in) Dia Tip Pen Body	016-0448-00	$24
0.46 mm (0.018 in) Dia Tip Pen Body	016-0449-00	$24
0.56 mm (0.022 in) Dia Tip Pen Body	016-0450-00	$24

Replacement Tips

0.35 mm (0.014 in) Dia Tip	016-0445-00	$18
0.46 mm (0.018 in) Dia Tip	016-0446-00	$18
0.56 mm (0.022 in) Dia Tip	016-0447-00	$20

Wet Ink Pen Accessories

Replaceable Wet Ink Pens Parts Kit	006-2968-01	$7.00
Extra Ink Single Cartridge	016-0649-00	$2.00

Inks for Polyester Film (3/4 oz Squeeze Bottle)

Brown	016-0423-00	$3.00
Green	016-0424-00	$4.50
Blue	016-0425-00	$3.00
Red	016-0426-00	$3.00
Black	016-0427-00	$3.00

Inks for Paper (3/4 oz Squeeze Bottle)

Black	016-0428-00	$5.00

Wet Ink Cleaning and Maintenance Systems

Ultrasonic Cleaning Tank	002-1555-00	$260
Cleaning Fluid with Strainer 5.2 oz	002-0920-01	$5.00
Pressure/Suction Cleaning Bulb	002-1560-00	$12
Magnifying Instrument	002-1558-00	$120
Pen Storage Humidifier	002-1559-00	$15

PLOTTING MEDIA

4662 Plotter Paper
Blank White Paper
280 x 432 mm (11 x 17 in) 100 Each

B-Size	006-2410-00	$10

Printed Paper
10 x 10 cm (11 x 16.5 in) Grid 100 Each

Linear Paper	006-1698-00	$12

10 x 10 cm (11 x 16.5 in) 100 Each

Linear Paper	006-1699-00	$12

10 x 3 Cycle (11 x 16.5 in) 100 Each

Semi-log Paper	006-1700-00	$12

10 x 2 Cycle (11 x 16.5 in) 100 Each

Semi-log Paper	006-1701-00	$15

2 x 3 Cycle (11 x 16.5 in) 100 Each

Full-log Paper	006-1702-00	$12

4662 A-Size Plotter Film
Quick Dry Plotter Film

8.5 x 11 in 50 Sheet Package	006-5939-00	$30

4663 C-Size Polyester Film
Antistatic Polyester Film

17 x 22 in, 100 Sheets	006-2835-00	$120

4663 C-Size Plotting Paper
Translucent Bond
18 in x 200 ft (2 Each) C-Size After Tear Off

Blank Roll Paper	006-2837-00	$40

Translucent Bond
18 in x 200 ft (2 Each)
Metric Size A2 After Tear Off

Blank Roll Paper	006-3473-00	$42

Translucent Bond
432 x 559 mm (17 x 22 in), 100 Each

Blank Sheet	006-3150-00	$15

Vellum, 100% Rag Content
432 x 559 mm (17 x 22 in) 100 Each

Blank Sheet	006-2836-00	$45

COPIER PAPER

4631, 4632 and 4635
Tektronix Standard Dry Silver Paper
216 mm x 152 m (8.5 in x 500 ft)

Single Roll	006-1603-00	$90
4 Roll Carton	006-1603-01	$320

4633A, 4634 and 4635
Tektronix High Performance Dry Silver Paper
216 mm x 152 m (8.5 in x 500 ft)

Single Roll	006-2432-00	$215
4 Roll Carton	006-2432-01	$750

4611/4612 Dielectric Hard Copy Paper
216 mm x 152 m (8.5 in x 500 ft)

2 Roll Package	006-2838-00	$35

4611/4612 Tektronix Dry Copy Toner

4.9 oz Bottle	006-2990-00	$22

PRINTER PAPER AND RIBBONS

4641 Printer Ribbon

Box of 12	119-0820-00	$180

4642 Printer
Paper-Tab Stock, Fan Fold,
270 mm x 279 mm, (10.6 x 11 in)

2500 Sheets/Carton	002-0262-01	$60
Paper Roll Box of 12	002-1084-01	$70
Ribbons Package of 4	002-1451-01	$70

4643 Printer Ribbon

Cassette	118-1314-00	$25

MAGNETIC MEDIA

4110 Series 8 inch Flexible Magnetic disk
512 Kbytes Formatted Capacity

Box of 10	119-1376-01	$110

4170, 4925 and 4926 Option 25 Flexible 5 1/4 inch Disk
650 Kbytes Formatted Capacity

Box of 10	119-1583-01	$55

4905 Options 31 & 32 Flexible 8 inch Magnetic Disk
315 Kbytes Formatted Capacity

Package of 10	119-0848-01	$115

4907 Flexible 8 inch Magnetic Disk
630 Kbytes Formatted Capacity

Package of 10	119-1011-01	$150

4905 Options 33 and 34
Hard Disk Pack Formatted Capacity

5 Mbyte	119-0855-00	$250

4909 Disk Cartridge
13 Mbyte

Formatted Capacity	119-1462-00	$275

4050 Series, 4923 and 4924
Certified Data Cartridge

300 ft Each Cartridge	119-0680-00	$30
Package of 5	119-0680-01	$120

Certified Data Cartridge

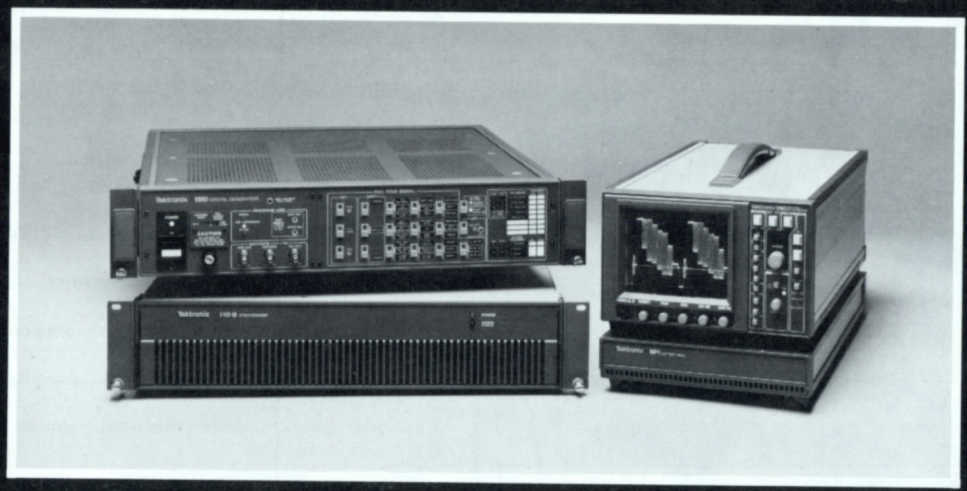
450 ft Each Cartridge	119-1439-00	$35

Certified Data Cartridge (4050 Series Only.)

600 ft Each Cartridge	119-1463-00	$45

TEK

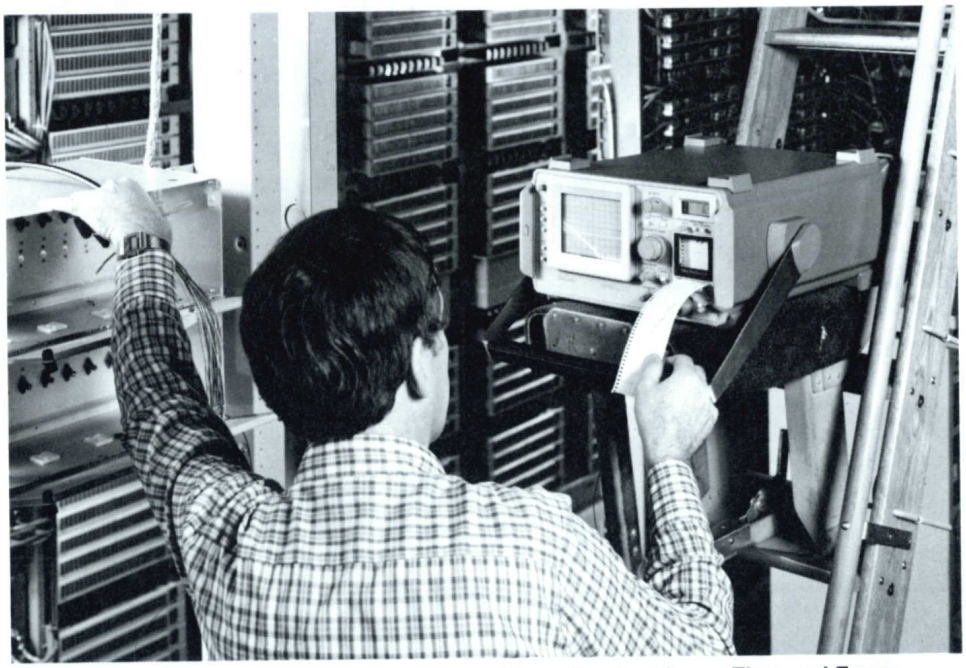
COMMUNICATIONS DIVISION



Providing quality instruments designed to test, time, measure and monitor a variety of television, RF, fiber optic, and data communications network signals is the responsibility of the Communications Division's three Oregon-based business units: Television Products, Frequency Domain Instrumentation, and Communications Network Analyzers. A sampling of products is shown below. A separate photo emphasizes three major new television-related instruments: 1910 Digital Generator, 110-S Synchronizer, and 1740 Waveform/Vector Monitor.

Electronic communications continue to impact mankind through newer and better equipment and applications. We are proud to be at the leading edge of these new technological opportunities. Through a cohesive network of domestic and international sales and service locations, each with personnel experienced and knowledgeable in the communications marketplace, we bring Tektronix performance and support to our Communications Division customers throughout the world.

FIBER OPTIC TDR CABLE TESTER



OF150 Fiber Optic TDR

LCD Readout Resolution to 0.1 dB/1.0 Meter

Accurate, Repeatable Measurements

Built-in Chart Recorder, Optional Recorder Output

Digital Storage Provides Easy to View Waveform and Noise Reduction

Two Selectable Pulse Widths

Portable — Operates from 12 Volt Vehicle System or Battery Pack

Unmatched Range

The OF150 is a high performance, easy to use, portable instrument that can perform repeatable, accurate distance and loss measurements on multimode optical fibers.

Typical applications include: splice measurement through a one-way cable loss of up to 21.5 dB to within ±0.1 dB; detection of fiber ends, (four percent Fresnel reflection) through a one-way cable loss of up to 42.5 dB; and measuring distance to discontinuities (such as splices, Fiber faults and ends) to 19.9 km, with one meter resolution.

Direct Readout Saves Time and Errors

The OF150 gives you direct LCD readout of results, eliminating voltage-to-power and time-to-distance computations and risk of operator errors. Direct readout assures accurate, repeatable measurements every time. A built-in chart recorder provides a permanent record of the waveform for reference and comparison.

Get an Accurate Picture of Splice Loss

Digital storage produces a consistently sharp, easy-to-view trace. Signal averaging and selectable filters help maintain waveform resolution, so that measurements are made as accurately at long distances as closer in.

Two filters provide signal averaging and incremental decreases in the RMS noise floor. Compared to Fast filter operation (fast sweep), the Medium filter (medium sweep) provides a 7.5 dB reduction and the Slow filter (slow sweep) a 15 dB reduction. By using the Fast-Medium-Slow selection, you can pick the optimum signal acquisition speed/noise reduction combination.

The OF150 also offers two selectable pulse widths. The short pulse increases resolution for close-in measurements, while the long pulse extends distance/loss measurement range.

Easy to Use

The OF150 combines high performance with ease of use. With Tektronix supplied manuals, craftspeople or technicians can learn to use this instrument in two hours or less.

Portability and Convenience

Its compact size, light weight and rugged design, plus the ability to operate easily from a 12 volt vehicle system or external battery pack, enables the OF150 to offer exceptional portability in a high performance instrument.

CHARACTERISTICS

OPTICAL TEST SIGNAL

Wavelength — 820 nm (nominal).

Displayed Pulse Width — Long Pulse: 5.5 m, ±1 m. Short Pulse: 1.5 m, ±0.3 m.

Displayed Noise on the Incident Pulse — <±1.0 dB peak (Fast filter).

System Pulse Rate — 4.762 kHz ±5 Hz.

Optical Output Amplitude — ≥25 μW Time-average power coupled into test fiber (50 μm core, 0.20 NA) (Long Pulse mode).

Optical Pulse Amplitude Stability — <0.4 dB drift over the duration of a Slow sweep.

Absolute Maximum Optical Output Amplitude — 200 μW time averaged power.

Displayed Pulse Risetime — <0.7 m from −20 dB point to −6 dB point.

Displayed Pulse Falltime — ≤5 m from trailing pulse corner to the +60 dB point relative to bottom of display range.

≤500 m from trailing pulse corner to the +30 dB point relative to bottom of display range.

≤2 km from trailing pulse corner to the +15 dB point relative to bottom of display range.

MEASUREMENT RANGE

Displayed RMS Noise Floor — +1.8 div, ±0.4 div from bottom of display range with Fast filter and 10 dB/div scale.

Decrease in RMS Noise Floor through Filtering — With Medium Filter: 0.75 div (7.5 dB). With Slow Filter: 1.5 div (15.0 dB).

Optical Input Sensitivity — ≤0.40 μW input for 30 dB above displayed RMS noise floor.

Dynamic Range — 105 dB (typical) between peak optical output pulse and RMS noise floor (Slow Filter).

Maximum Round Trip Fiber Loss for Fiber End Detection — 85 dB typical (assuming 4% Fresnel reflection).

Maximum Round Trip Fiber Loss for ±0.1 dB Scattering Signal Measurements — 43 dB typical (dependent on fiber characteristics).

CRT VERTICAL DISPLAY

Vertical Scales — 10 dB/div and 2 dB/div (10 div).

dB Scale Accuracy — ±0.5 dB over any 10 dB increment from +20 dB to +70 dB, relative to bottom of display range.

Incremental dB Scale Accuracy — ±0.05 dB (typical) over any 1 dB, increment from +10 dB, to +70 dB relative to bottom of display range.

CRT HORIZONTAL DISPLAY

Distance Scales — 1 m/div to 1000 m/div.

Display Limits — −5 m to 19.9 km from front-panel connector.

Sweep Time — 0.15 s (Fast); 3.15 s (Med); 55 s (Slow).

On-screen Distance Calibration — 4.88 ns/m.

"Zero" Distance Reference Accuracy — ±0.5 m on screen.

LCD NUMERIC READOUT

Distance Readout Range — 0 km to 19.9 km.

Distance Readout Resolution — 1 m.

Distance Cal Factor Range — 4.8 ns/m to 5.0 ns/m.

Distance Cal Factor Accuracy — Within 0.01 ns/m of panel indication at center of scale (4.900); within 0.02 ns/m of panel indication at scale end points.

Loss Measurements — Readout Range: −25 dB to +25 dB (one way fiber loss) from center reference point. Readout Resolution: 2 dB/div scale: 0.1 dB; 10 dB/div scale: 0.5 dB.

Distance Measurement Accuracy — ±0.3%*1 ±uncertainty in Fiber Cal Factor.

*1 *Instrument timing in accuracy plus distance cal factor indication error.*

NEW

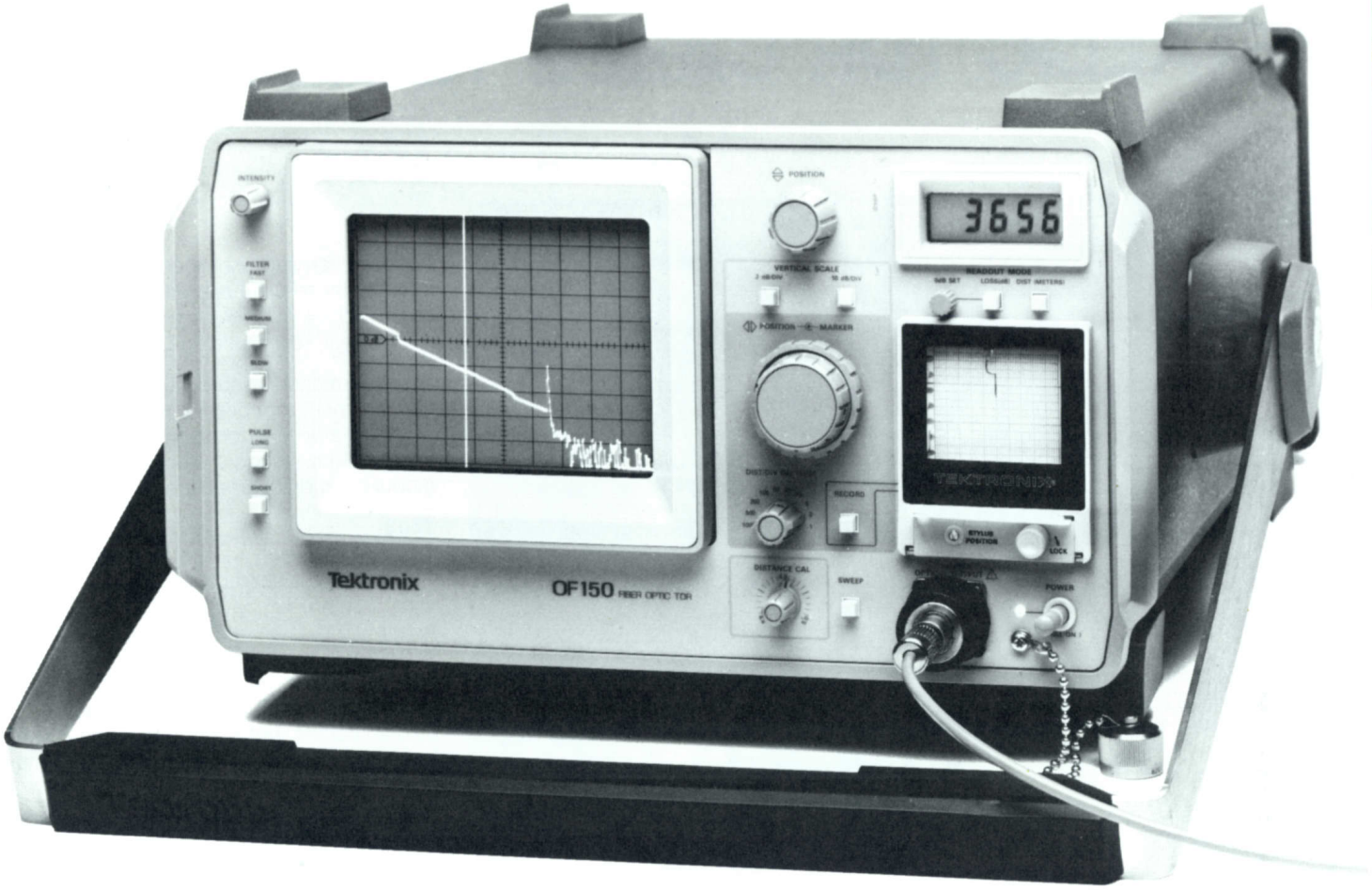


CHART RECORDER

Chart Dimensions — 40 mm x 125 mm (corresponding to the full CRT graticule area).

Chart Distance Scale Linearity — ±0.2 major division match at any point.

Chart Vertical Scale Linearity — ±5% of deflection from center, ±0.3 major division.

Chart Running Time — 16 s.

SAFETY

Meets Class I Laser product safety classification under Radiation Control for Health and Safety Act of 1968. Optical output connector interlock prevents optical output when interlock is open.

ENVIRONMENTAL CHARACTERISTICS

The OF150 meets the specifications of MIL-T-28800B, Type III, Class 3, Style C except for Radiated Emission specification RE-01.

Altitude — Operating: 4600 m (15,500 ft). Nonoperating: 12 000 m (40,000 ft).

Temperature — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width (Without front cover, handle or feet)	327	13.1
Height	175	7.0
Depth	499	20.0
Weight	**kg**	**lb**
Net (Includes accessories except manual)	16.6	37.0

POWER REQUIREMENTS

Ac Operation — 90 V ac to 132 V ac, 45 Hz to 440 Hz, 180 V ac to 250 V ac, 45 Hz to 440 Hz 24 W nominal (55 W maximum).

Dc Operation — 10 to 16 V dc 20 W nominal (33 W maximum).

INCLUDED ACCESSORIES

Optical fiber interface cable, 1 meter long, Deutsch Connector on one end, protective cover on the other end (175-4572-00); roll of chart recorder paper (006-3618-00); battery power cord (161-0149-00); ac power cord (161-0118-00); interlock contact ring (352-0654-01); replacement lens assembly (131-2741-02); protective cover for fiber optic interface cable (200-2736-00); cable retainer (343-0170-00); ac power cord (161-0149-00); manual.

NEW XY1 Output Module

The XY1 provides signals which correspond to the trace on the CRT and can be used to drive an external analog plotter or chart recorder.

ELECTRICAL SPECIFICATIONS XY1 OUTPUT MODULE

X (Horizontal) Scale — 0.1 ±5% per major division on CRT.

X Gain — Sets X axis full scale between 0.5 V to 1.2 V.

Y (Vertical) Scale — 0.1 V ±5% of signal per major division on CRT.

Y Offset — Sets Y axis mid-scale between 0.1 V and 0.9 V.

Z Output (Pen Lift) — TTL compatible, nominal +5 V. Logic output internally selectable.

Sweep Time — 14 s ±1 s.

ORDERING INFORMATION

OF150 Fiber Optic Time Domain Reflectometer **$18,500**

Option 01 — XY1 Output Module ..... **+$300**

Option 05 — 850 nm Wavelength (nominal) ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

OPTIONAL ACCESSORIES

C-5C Camera **$530**

Hard Case (Transit) — Order 016-0658-00 ..... **$625**

Soft Case — Order 016-0659-00 ..... **$125**

Chart Paper — One roll Order 006-3618-00 ..... **$9.25**

Chart Paper — 25 rolls Order 006-3618-01 ..... **$210.00**

Chart Paper — 100 rolls Order 006-3618-02 ..... **$695.00**

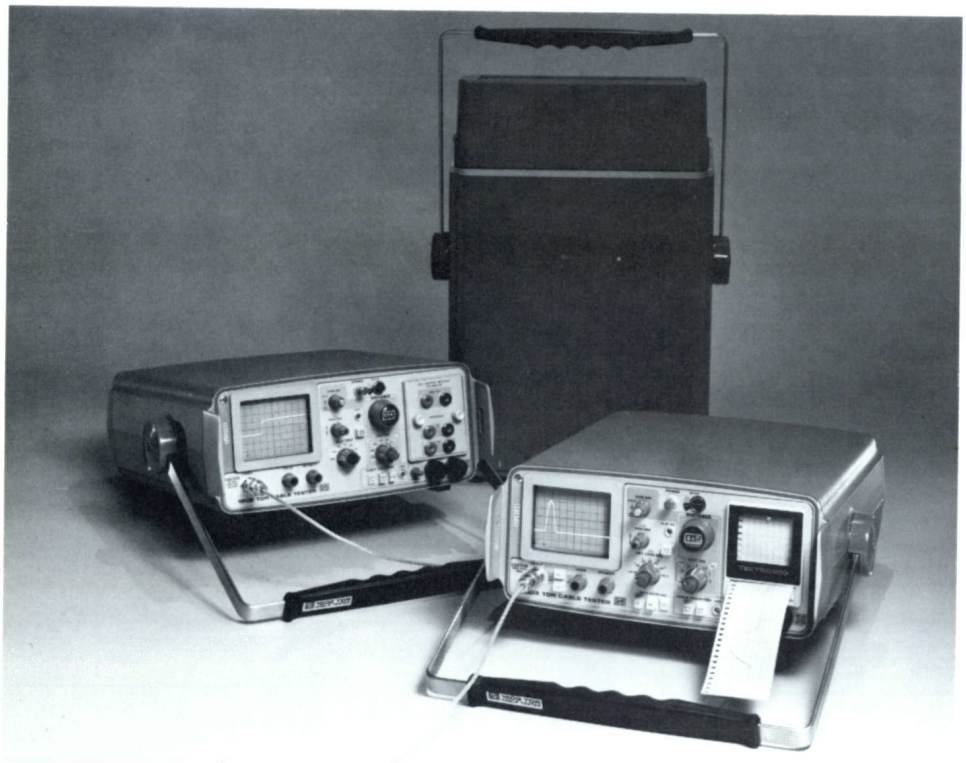
Optical Receptacle Connector — One each Order 131-2741-02 ..... **$60**

Optical Receptacle Connector — 10 each Order 013-0207-02 ..... **$375**

Accessory Kit (Deutsch) — Order 015-0474-00 ..... **$695.00**

CRT Visor — Order 016-0653-00 ..... **$30**

METALLIC TDR CABLE TESTERS



Portable —
Battery Powered, Self-Contained, Lightweight

Rugged —
Meets MIL-T-28800, Type III, Class 3, Style A

Versatile —
Test Any Type Paired Conductor and Coax Cable

Easy to Use —
Produces Results with Minimal Operator Training

Time Domain Reflectometry TDR*1

The portable, rugged 1502 and 1503 TDR Cable Testers are field maintenance tools that are simple to operate and will test any transmission cable under virtually any conditions. The 1502 is appropriate for testing coax and other cables in aircraft, ships, radar sites, etc. The 1503 tests long runs of coax or twisted pair cables in telephone and other communications applications.

These units use a technique called Time Domain Reflectometry (TDR) to identify and locate cable faults. When connected to a line in the cable, the unit sends out an electrical pulse that is reflected back to the unit by a fault in the cable. Fault type is identified by the shape of the display, and fault distance is determined by the displayed interval from the test pulse to the fault pulse.

*1 *Also known as cable radar.*

For easy carrying and operating in tight spaces, these units are lightweight and small and will operate at least five hours on the internal, rechargeable batteries.

Since permanent records are useful in cable maintenance, an optional, plug-in chart recorder is available for paper recording of the test. The standard plug-in X-Y output module can drive an external X-Y Recorder.

1502
This unit is directly calibrated in reflection coefficient (rho) and distance. The 1502 uses a step-pulse and provides fault resolution to 0.6 inch on short cables. The 1502 performs to a maximum of 2000 feet, but with decreasing resolution as the fault distance increases. The unit is matched to 50-ohm cables, but may be used on others by adjusting the front panel GAIN control or using optional impedance adaptors.

1503
For long cables, the 1503 provides high-energy, ½-sine-shaped pulses. Range of the 1503, dependent upon cable type, is up to 50,000 feet. Resolution capability provides for resolving faults as close together as three feet on short cables. Impedance levels of 50, 75, 93 and 125 ohms are selectable.

1503 Option 01
1503 Option 01 has Distance Cal switches that make it more convenient for fault location in a variety of cables including coax. When the 1503 Option 01 has been calibrated for each cable before trouble occurs, and the records are kept, the Distance Cal switches can be set exactly and damage location can begin immediately.

Metric Instruments (1502, 1503)
For distance measurements in meters, instead of feet, there is Option 05 of both the 1502 and 1503. These instruments are fully metric versions of the 1502 and 1503 with no conversion from feet to meters involved.

The 1502 Option 05 has a distance resolution of 15 mm and measures 500 meters.

The 1503 Option 05 has a resolution of 0.9 meter and measures 10 000 meters.

1502 Short Range TDR Cable Tester

CHARACTERISTICS

TEST SIGNAL

Shape — Step rise.

Amplitude — 225 mV nominal (into 50 Ω load), dc coupled.
Aberrations — Within ±5% during 1st 10 ft after rise. Within ±0.5% peak beyond 10 ft Noise Filter "out."
System Reflected Rise — ≤0.07 ft (≤140 ps).
Jitter — ≤0.02 ft (≤40 ps) for X.1. ≤0.1 ft (≤200 ps) for X1.
Test Connector — BNC.
Termination — 50 Ω, within ±2%.
Maximum Input — DO NOT APPLY EXTERNAL VOLTAGE.

VERTICAL SYSTEM

Display Range — ±4 divisions.
Accuracy — Within ±3%.
Calibration Point — 2 divisions = 1 ρ.
Deflection Factor — 5 mρ/division to 500 mρ/division, 7 steps, 1-2-5 sequence.
Variable — ≥3.5:1 from calibration point.
Displayed Noise — Noise Filter switch "out": ±5 mρ or less. Noise Filter switch "in": ±2 mρ or less.

HORIZONTAL SYSTEM

Distance Controls
Distance Dial — Range: 0 to 100 ft for X.1. 0 to 1000 ft for X1. Accuracy: Within ±2% of reading ±0.05 ft for X.1. Within ±2% of reading ±0.5 ft for X1.
Feet/Div Control — Range: 0.1 to 20 ft/division for X.1. 1 to 200 ft/division for X1. Accuracy: Within 2% of full CRT screen.
Cable Dielectric Scales (Vρ/Vair) — Solid Poly, 0.66; Solid PTFE, 0.70; Other Var, 0.55 to 1.0. Var is calibrated for air when turned fully cw.
Sweep Repetition — 40 Hz within +0 Hz, −10 Hz with Noise Filter switch "out." 4 Hz within ±20% with Noise Filter switch "in". 20 s/sweep nominal in chart recorder mode (dependent upon chart recorder).

UNIQUE CHARACTERISTICS (1502 OPTION 05)

TEST SIGNAL

Aberrations — Within ±5% during 1st 300 cm after rise. Within ±0.5% peak beyond 300 cm Noise Filter "out."
System Reflected Rise — ≤2.1 cm (≤140 ps).
Jitter — ≤0.6 cm (≤40 ps) for X.1. ≤3 cm (≤200 ps) for X1.

HORIZONTAL SYSTEM

Distance Controls
Distance Dial — Range: 0 to 25 m for X.1. 0 to 250 m for X1. Accuracy: Within ±2% of reading ±0.02 m for X.1. Within ±2% of reading ±0.2 m for X1.
Meters/Div Control — Range: 0.025 to 5 m/division for X.1. 0.25 to 50 m/div for X1.

1503 Long Range TDR Cable Tester

CHARACTERISTICS

TEST SIGNAL

Shape — ½ sine within ±20%.
Amplitude — 10 V ±20% unterminated. 5 V ±20%, terminated, ac coupled.
Aberrations — −30 dB p-p. (Equivalent to ±1.6%).
Duration — ≤10 ft (10 ns),*1 ≤100 ft (100 ns),*1 ≤1000 ft (1000 ns).*1

*1 *Duration times are within ±20% at half amplitude.*

Jitter — ≤1 ft for X10 (≤2 ns). ≤10 ft for X100 (≤20 ns).
Test Connector — BNC.
Termination — 50 Ω, 75 Ω, and 93 Ω, within 1%; 125 Ω within 3%.
Maximum Input — ±400 V (dc + peak ac at maximum frequency of 440 Hz).

VERTICAL SYSTEM

Display Range — ±4 division.
Accuracy — Within ±0.25 dB (within ±3%).
Calibration Point — 2 division = 0 dB.
Deflection Factor — 0 to 60 dB, 7 steps, 10 dB per step.
Variable — 0dB to 18 dB additive to steps.
Displayed Noise — Noise Filter switch "out": −80 dB RMS, random. Noise Filter switch "in": −86 dB RMS, random.

HORIZONTAL SYSTEM

Distance Controls
Distance Dial — Range: 0 to 2,500 ft at X10. 0 to 25,000 ft at X100. Accuracy: Within 2% of reading ±2 ft for X10. Within 2% of reading ±20 ft for X100.
Feet/Div Control — Range: 5 to 500 ft/div at X10. 50 to 5000 ft/div at X100. Accuracy: Within 2% of full CRT screen.
Cable Dielectric Scales (Vρ/Vair) — Solid Poly, 0.66; Foam Poly, 0.81; Var, 0.31-1.0. Var is calibrated for air when turned fully cw.
Distance Cal Scales, Option 01 Only (Vρ/Vair) — Selectable from 0.2 to 1.0 in 0.01 increments.
Sweep Repetition — 40 Hz within +0 Hz, −10 Hz with Noise Filter switch "out." 20 s/sweep nominal in chart recorder mode (dependent upon chart recorder). 4 Hz within ±20% with Noise Filter switch "in."

UNIQUE CHARACTERISTICS (1503 OPTION 05)

TEST SIGNAL

Duration — ≤3 m (10 ns),*1 ≤30 m (100 ns),*1 ≤300 m (1000 ns).*1
Jitter — ≤0.2 m for X1 (≤2 ns). ≤2 m for X10 (≤20 ns).

*1 *Duration times are within ±20% at half amplitude.*

HORIZONTAL SYSTEM

Distance Controls
Distance Dial — Range: 0 to 500 m at X1. 0 to 5,000 m at X10. Accuracy: Within 2% of reading ±0.2 m for X1. Within 2% of reading ±2 m for X10.
Meters/Div Control — Range: 1 to 100 m/division at X1. 10 to 1000 m/division at X10.

COMMON CHARACTERISTICS (1502 & 1503)

POWER REQUIREMENTS

Ac Power — Line Voltage: 117 V ac ±20% and 234 V ac ±20%. Line Frequency: 48 to 410 Hz.
Dc Power
Battery Pack Operation — At least 5 hours (+20°C to +25°C charge and discharge temperature) including 20 chart recordings.
Full Charge Time — 16 hours.
Typical Charge Capacity

Charge Temperature	Discharge Temperature		
	−15°C	+20°C to +25°C	+55°C
0°C	40%	60%	50%
+20°C to +25°C	65%	100%	85%
+40°C	40%	65%	55%

EXTERNAL RECORDER INTERFACE (STANDARD X-Y MODULE)

Horizontal — 0.1 V/div, source impedance is 10 kΩ.
Vertical — 0.09 to 0.13 V/div (adjustable), source impedance is 10 kΩ.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width (with handle)	315	12.4
Width (without handle)	300	11.8
Height	127	5.0
Depth (handle extended)	475	18.7
Depth (handle not extended)	419	16.5
Weights	**kg**	**lb**
Net (with front cover and accessories)	8.2	18.0
Net (without front cover or accessories)	7.3	16.0
Domestic Shipping (complete) ≈	11.1	24.4
Export Shipping (complete) ≈	16.3	36.0

INCLUDED ACCESSORIES

Watertight front cover (200-1759-00); TDR slide rule for 1502 only (003-0700-00); 50 Ω BNC terminator (011-0123-00); precision 50 Ω cable for 1502 only (012-0482-00); viewing hood (016-0297-00); X-Y output module (016-0606-00); 110 V ac replacement fuses (for front panel) for 1502 only (159-0032-00) or 220 V ac (159-0029-01); power cord (161-0066-00); mesh filter (CRT) (378-0055-00); BNC female-to-female adaptor for 1502 only (103-0028-00); 9 ft BNC-to-clip-lead cable (012-0671-02); manual.

ORDERING INFORMATION

1502 TDR Cable Tester **$5,800**
1503 TDR Cable Tester **$4,900**
Option 01 — (Distance Cal for 1503 only) ..... **+$375**
Option 04 — With Cable Tester Recorder **$1,050**
Option 05 — With Cable Tester Metric Version) ..... **NC**
Option 76 — GM (P7) Phosphor ..... **+$35**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz

OPTIONAL ACCESSORIES (1502)

Chart Recorder — Order 016-0506-04 ..... **$1,100**
Chart Paper — One Roll Order 006-1658-01 ..... **$7.50**
Chart Paper — 100 Roll Case Order 006-1658-02 ..... **$550**
Accessory Pouch — Order 016-0351-00 ..... **$25**
Static Suppressor — (helps protect front end from damage). Order 011-0132-00 ..... **$45**
Impedance Adaptor —
50/75 Ω. Order 017-0091-00*1 ..... **$115**
50/93 Ω. Order 017-0092-00*1 ..... **$115**
50/125 Ω. Order 017-0090-00*1 ..... **$115**
*1 *Should be purchased with following two parts:*
Connector, BNC Female-to-GR —
Order 017-0063-00 ..... **$43**
Connector, BNC Male-to-GR —
Order 017-0064-00 ..... **$75**

OPTIONAL ACCESSORIES (1503)

Chart Recorder — Order 016-0506-04 ..... **$1,100**
Chart Paper — One roll Order 006-1658-01 ..... **$7.50**
Chart Paper — 100 roll case
Order 006-1658-02 ..... **$550**
Isolation Network — (for balanced lines).
Order 013-0169-00 ..... **$155**
Adaptor Cables (BNC-to-Clips) — 9 foot
Order 012-0671-02 ..... **$60**
30 foot Order 012-0671-03 ..... **$70**
Accessory Pouch — Order 016-0351-00 ..... **$25**
Direct Current Adaptor with Filter (for use with standard 12 V automobile lighter plug with negative ground).
25 Foot Cord Order 015-0327-00 ..... **$175**

LOGISTICS INFORMATION

For logistics data, see Tektronix Logistics Data Book.

COMMUNICATIONS NETWORK ANALYZERS

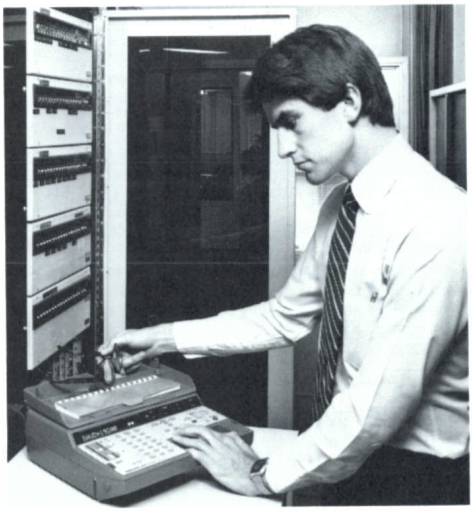
CONTENTS

834 Programmable Data Communications Tester 153
834RDA ROM Development Aid 155
834 ROM Packs 156
851 Digital Tester 158

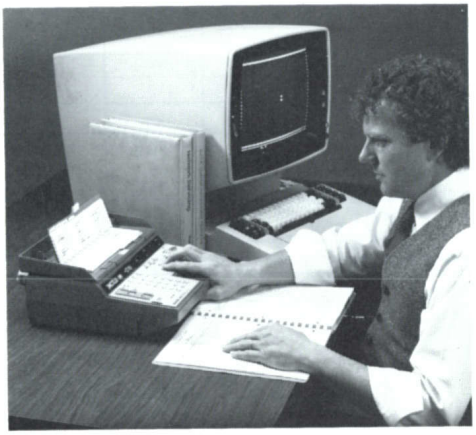
Bisynchronous System Exercising

Communications System Monitoring

Communications Equipment Check-out



Data Link Testing



SDLC/SNA Testing

834

Programmable

Allows Automation of Tests

Easy to Operate

Handles ASYNC/ASYNC BLOCK/BISYNC/ HDLC/SDLC

Portable and Lightweight

The Tektronix 834 Programmable Data Communications Tester is a powerful network troubleshooter designed to meet the demand for cost and time-effective first-line field service. The 834's portability (5.5 kg, 12 lb), ruggedness, and ease of use gives you a welcome independence from bulky, expensive equipment.

The 834 is compatible with EIA RS-232, and CCITT V.24 interfaces and can be expanded to many others with appropriate options. The 834 provides: system monitoring, DTE and DCE simulation to evaluate the entire network, bit error rate testing for analyzing phone lines and modems, the ability to calculate and confirm block check characters, and internal self-diagnostics.

The fast 19.2 kilobaud rate lets you test the most modern networks. The bright 16-character front panel display is fully decoded in ASCII, EBCDIC, HEX, your own, or optional character set.

We have programmed new features along with common test routines and setups into a series of application ROM packs that easily slip into the 834 and extend its testing capabilities in specific areas.

MODES OF OPERATION

Monitor
The 834 monitors and records activity occurring on the interface without interfering with data transmission. The major control line status is recorded with each character. Trigger capability allows selective capture of data (refer to Triggering).

Modem (DCE) Simulation
In this mode, the 834 functions as DCE (Data Communications Equipment) or modem simulator for testing the DTE (Data Terminal Equipment). Messages can be sent to the UUT (Unit Under Test), and messages received from the UUT can be examined and cause further action by the 834. The sequence of events is controlled by a stored program (in the 834) which can be manually entered or stored in a user defined ROM (refer to Programmability).

Terminal (DTE) Simulation
In this mode, the 834 performs as DTE (Data Terminal Equipment) or terminal simulator for testing the DCE (Data Communications Equipment) side of the interface. Otherwise, operation is similar to the modem (DCE) simulator mode described above.

Bert Mode
In this mode the 834 performs bit and block error rate testing using the 511-bit CCITT standard pseudo-random pattern. Additional patterns and testing capabilities are available with appropriate ROM pack.

Self Test Mode
In this mode, internal diagnostics and excercising routines can be called up by the operator to verify that the 834 is functioning properly.

CHARACTERISTICS

INTERFACE COMPATIBILITY

Compatible with EIA RS-232 and CC1TT V-24 interfaces. Optional interfaces also available.

DATA TRANSFER

Data Transmission Timing — Synchronous and asynchronous.

Communications Mode — Half or full-duplex.

Bits Per Character — 5, 6, 7, 8, 9; characters with five bits do not include parity; characters with nine bits are available in asynchronous mode with parity.

Codes — ASCII, EBCDIC, HEX standard (others available with application ROM packs).

DATA TRANSFER RATES

Internal (Crystal Controlled) — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 7200, 9600, and 19,200 bits/s; (synchronous full-duplex up to ≤9600 bits/s).

External — Limited to maximum of 19,200 bits/s; (synchronous full-duplex up to ≤9600 bits/s).

Parity — None, odd, even, all mark, all space.

RTS/CTS Delay (Half-Duplex Mode Only) — Programmable from 0 ms to 9999 ms. (Defaults to 200 ms if not programmed.)

Accuracy — +5 ms, −15 ms.

Block Check Characters — CRC-16, CRC-CCITT, LRC; (expanded with ROM packs).

Bit Error Rate/Block Error Rate Tests — The 834 uses the 511-bit CCITT standard pseudo-random pattern sent in blocks of 1000 bits. Errors are counted continuously or over a test length of 10^5 or 10^6 bits stored in error, blocks sent, blocks in error, and sync faults. See 834R03A Link Test ROM Pack for additional capabilities.

SET-UPS

ASYNCHRONOUS OPERATION

Stop Bits — Transmits 1, 1.5 or 2; responds to 1.

End of Frame — One programmable character in any bit combination; (defaults to 0A); (ASCII New line).

Timing — Normal or isochronous.

SYNCHRONOUS OPERATION

Synchronizing Character — Programmable to require any 1 or 2*1 characters (defaults to 32 32).

End of Frame — Programmable to recognize any of a number of idle conditions (Mark, Space, Syn) and/or a single character (defaults to 37, EBCDIC EOT).

Clock — Normal, derived, DTE.

**1 If 2, they may be different.*

HDLC OPERATION

NRZI — On or off.

Clock — Normal, derived, DTE.

TRIGGERING

Trigger Location in Buffer — Start, center, end.

Match (Source of Data Being Searched for Trigger Events) — None, DTE, DCE.

Trigger Sequence — Programmable to require a sequence of 0 to 25 characters (0 to 5 if no mask programmed).

Mask Sequence — Programmable to mask a 0 to 25 character trigger sequence.

Error Conditions — In Async: Parity or frame error. In Sync: Parity error. In HDLC: CRC error, abort sequence or short frame (<32 bits).

Marker — Low-to-high or high-to-low transition of marker can be selected.

Buffer Capacity — 2699 character (expanded with some ROM packs).

PROGRAMMABILITY

Program Steps — 99 available.

Message Lengths — 50 totaling 3000 bytes.

Data Captured — Always the last 2699 character received before the program stops or before Stop is pressed; (number of characters expanded with some ROM packs).

Basic Instruction Set (Additional Instructions Available in ROM Packs)

HALT: mm

Stop and display message mm.

SEND: mm

Send contents of message buffer mm as a frame.

RECEIVE

Obtain next complete data frame for processing.

COMPARE: mm

Search frame for a match with message buffer mm.

JUMP EQ: ss

Jump to step ss if a match is found.

JUMP NE: ss

Jump to step ss if a match is not found.

JUMP: ss

Jump to step ss.

IF TIME: ss

Jump to step ss if the timer expires.

TIME OUT # pp

Start timer with value in parameter pp.

MASK: mm

Use message mm for mask during COMPARE operation.

WAIT # pp

Start time with value in parameter pp and do not proceed to following step until timer expires (10 to 9999 ms).

INTERFACE ACCESS PANEL

All Pins (2 through 25) — Accessible.

Major Control Lines — May be connected or disconnected from the 834 via rocker switches. These include: TXD, RXD, RTS, CTS, DSR, GND, CD, TX0 (DCE), RX0 (DCE), DTR, TXO (DTE).

Interface Configuration — Can be modified using jumper straps and the +12 (space) and −12 (mark) V sources provided on panel. Control lines CD, RTS, CTS, DSR, and DTR are program controllable with most ROM packs.

Probe — Via a dual LED display, allows checking the current condition of any of the lines.

Marker — Allows the status of any interface line to be stored with each received character. This storage is in conjunction with the major control lines automatically recorded (CD, RTS, CTS). The marker, CD, RTS, CTS, DSR, and DTR can also be tested under program control with most ROM packs.

DISPLAY

Alphanumeric Display — 16 fluorescent digits. (Each digit is a 5 x 7 dot matrix 9 mm high.)

Status Indicator for Control Lines — LED.

PHYSICAL CHARACTERISTICS

Dimensions ≈	mm	in
Width	305	12.1
Height	102	4.0
Depth	306	12.4
Weight ≈	**kg**	**lb**
Net	5.5	12.0

POWER REQUIREMENTS

Line Voltage Ranges — 90 V ac to 132 V ac; 180 V ac to 250 V ac; 115 V nom.

Line Frequency Range — 48 Hz to 440 Hz.

ENVIRONMENTAL CHARACTERISTICS

Temperature Range — Operating: 0°C to 50°C (32°F to 122°F). Nonoperating: −40°C to 75°C (−40°F to 167°F).

Humidity — 95% relative humidity, 30°C to 60°C.

Altitude — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

Shock — 50 gs, ½ sine. 11 ms duration in each major axis.

OPTIONAL INTERFACES

Current Loop Interface (Option 02) — Operates in both two-wire (simplex or half-duplex) and four-wire (full duplex) modes. The current source for each of the two loops is selectable; either externally or internally supplied. Internal current sources are 20 mA and 60 mA.

RS-449 Interface (Option 03) — Supports both differential (RS-422) and single-ended (RS-423) circuits. This interface permits the use of a 9-pin connector for secondary channels along with the main 37-pin connector.

MIL-STD-188C Interface (Option 04) — Conforms to the military communication system technical standard MIL-STD-188C. Menu selectable, inverted or normal data allows the 834 to easily switch to an RS-232 compatible mode.

The MIL-STD-188C interface is factory installed only. The current loop and RS-449 interfaces are external PODS which can also be purchased as optional accessories and added at any time. When a POD interface is not connected, the standard RS-232 interface is functional.

INCLUDED ACCESSORIES

RS-232 three connector cable assembly, front panel jumper set (198-4006-00); US 115 V power cord (161-0066-00); manual.

ORDERING INFORMATION

834 Programmable Data Communications Tester **$3,990**

Option 02 — Current Loop Interface ..... +$325
Option 03 — RS-449 (RS-422/RS-423) Interface ..... +$750
Option 04 — MIL-STD-188C ..... +$350

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A
Option A2 — UK 240 V/13 A
Option A3 — Australian 240 V/10 A
Option A4 — North American 240 V/15 A

ROM PACKS

834R01 — General Purpose ROM Pack **$280**
834R02A — Bisynchronous ROM Pack (EBCDIC) **$350**
834R03A — Link Test ROM Pack **$370**
834R04 — HDLC/X25 ROM Pack **$450**
834R05 — Extended Instruction Set ROM Pack **$175**
834R06 — Bisynchronous ROM Pack (ASCII) **$350**
834R07 — PARS/IPARS ROM Pack **$375**
834R10 — SDLC/SNA ROM Pack **$450**
834R11 — Extended Monitor ROM Pack **$425**
834R13 — SDLC/SNA (FID3) ROM Pack **$450**
834RDA — ROM Development Aid ROM Pack **$1,200**

OPTIONAL ACCESSORIES

Current Loop Pod Accessory — Order 015-0361-00 .. **$350**
RS-449 Interface — Order A6741 ..... **$750**
Diagnostic ROM Pack — Order 067-0986-00 ..... **$480**
Carrying Case — Order 016-0672-00 ..... **$80**
Break Out Box — Order 015-0258-00 ..... **$190**

A variety of training accessories are also available including workbooks, video tapes, etc.

Additional information available in the 834 Selection Guide (request number 35W4922). Request copies at your local sales office or via the return card in this catalog.

834RDA

The System for Developing Customer User ROMs for 834 ROM Packs

The Tektronix 834RDA is the tool that gives users the ability to automate and extend the capabilities of the 834 Programmable Data Communications Tester by developing custom application ROMs for use with 834 application ROM packs.

The 834RDA supports the generation of user-defined programs, setups and messages. It also aids the user in extending the Baud, Code, Idle and transfer function directory menus by adding new menu entries.

PROMs are developed by building a ROM image in the 834 System. The ROM image is the entire contents of the ROM you are creating, including all the messages, programs, power-up setups and transfer functions that you develop. The 834RDA uses the RS-232 or an optional port on the 834 to interface to an external PROM programmer, a printer or terminal, or a unit under test. The 834RDA and 834 are used with an external PROM programmer to read and write PROMs. A terminal or printer used with the system produces formatted listings of the ROM image contents. With the 834 connected to the unit under test, the ROM image can be executed to verify operation and correctness.

The 834RDA also contains the Extended Instruction Set available in most 834 ROM packs.

FUNCTIONS OF THE ROM DEVELOPMENT AID

Save Program/Setup Function
The Save Program/Setup Function provides an easy method of saving individual instrument setups or simulation programs for storage in ROM. These setups and simulation programs will be callable by the user, or may be called up by preprogrammed test routines.

Record Mode
In Record Mode all keystrokes are recorded in the order that they are entered until the exist command is executed. Afterwards, the keystroke sequences may be edited. Record Mode is particularly useful for preprogramming 834 operations or test routines. It can also be used to create individual instrument setups or simulation programs for storage in ROM. The user can also easily set up automated test sequences in Record Mode by the call-up of previously programmed instrument setups and simulation programs.

Form Entry Functions
Several types of entries can be created using the Form Entry Functions. These include menu additions (baud rates, translation code tables, directory entries, and sync idle characters); keystroke sequences (power up and normal); character strings (for addition to message buffers). These functions can also be used to edit or modify existing programs or routines.

New Key Codes
The 834RDA includes two additional Code menu items. The Keys translation code produces a one-character representation of each key and is used when editing key sequences. The Display translation code makes all 834 display characters available to the user for building new code translation tables.

Input-Output Functions
The 834RDA System can accept input from any PROM burner that supports the TEK HEX format and has an RS-232 interface. Error detection checks are made to assure correct image transfer from the PROM programmer to the 834. The ROM image contains all of the completed entries plus the appropriate "overhead" data such as header, trailer, byte counts and checksum information. Upon completion of new entries or changes to the ROM image contents, the 834RDA ROM Development Aid can send a completed ROM image back to the PROM burner.

A listing of the entire ROM image or of individual entries can be sent to a printer or terminal for documenting purposes.

834RDA Menu
Level 1:
Copy Entry, Replace Entry, Delete Entry, Write 2 k, Write 4 k, Read ROM, Clear ROM, Print ROM.

Level 2:
HDR:, Size =, (list of additional entries as created).

Level 3:
Form Keys, Form Messages, Form Directory, Form Baud, Form Idle, Form Code, Form Pupkeys.

Program Edit Functions
The program edit functions enable users to insert and delete program steps. The resulting program is automatically renumbered to reflect the changes and all Jump and Call instructions will be adjusted accordingly.

Program Debut Functions
The program debug functions enable users to interrupt an executing 834 program, cause single-step program execution, set a breakpoint and display or change program steps, parameters, and messages.

ADDITIONAL INFORMATION

The 834RDA should be used with an 834 having level 05 or greater software. This can be verified by placing the 834 in self-test mode; scrolling down two levels to the LIST-DSROM display, then over one entry to LIST-CSROMØ. Press the start key; the display will read "CSRMØ;PN=Ø836-Ø5" or similar. This is the part number of the ROM containing the pertinent 834 software, and the last two digits should be 05 or greater.

A level 05 or greater ROM is supplied with each RDA in case it is needed. If it is not, the ROM can be erased and used for recording your custom routines.

If additional information or updates are required, contact your local Tektronix Sales or Service Center.

The 834RDA System is compatible with several PROM burners. Tektronix Application Note 35AX-4780 is available with additional detail on PROM programmer compatibility, selection criteria and operation information.

Order 834RDA ROM Pack
Development Aid **$1,200**

Option 01
Option 01 adds the following instructions to the 834RDA: PACKFRAME, HEX CONVERSION, AND, OR and deletes the Print ROM function available in the standard 834RDA ..... **N/C**

834 ROM Packs

834 ROM packs are firmware extensions of the 834 Programmable Data Communications Tester. These products all contain the extended instruction set as listed on this page. They (except the 834R01) also include program debug and edit functions plus the unique capabilities listed for each individual ROM Pack.

Additional information is available in the 834 Selection Guide (request number 35W-4922). Request copies at your local sales office or via the return card in this catalog.

In each ROM Pack, at least one ROM space is reserved for customer use. Each ROM space can accommodate a 2 k or 4 k ROM or EPROM. The custom ROM area of the ROM Pack can be programmed using 2716, 2732, 2516 or 2532 single power supply EPROMs or combination of the above.

As new ROM Packs have been introduced and existing ROM Packs enhanced, the firmware in the 834 has been expanded. The description for each ROM Pack includes the 834 firmware revision level required to make available all the capabilities of the ROM Pack. New 834's are shipped with the latest firmware and will support all the 834 ROM Packs in this catalog.

The software level of older 834s can be easily verified as follows:
Place 834 in Self-Test mode.
Scroll down two levels (press ↓ key twice) to the LIST DSROM display.

Press the → key once to obtain the LIST CSROMØ display.

Press Start key.

The display will read CSROMØ=PN=Ø836-XX. The last two digits indicate the software level of the 834 Data Communications Tester.

Contact your local Tektronix Sales or Service Center if additional information or updates are required.

Extended Instruction set,

11 LOAD # pp
Load register with value in parameter PP

12 STORE # pp
Store register value in parameter PP

13 COMPARE # pp
Compare register value to value in parameter PP

14 INCRMNT # pp
Increment value in parameter PP by one

15 DECRMNT # pp
Decrement value in parameter PP by one

16 DISPLAY # pp
Display value in parameter PP

17 LOAD: mm
Load register with character from message MM

18 STORE: mm
Store register value in message MM

19 DISPLAY: mm
Display message MM

20 CLEAR: mm
Clear message MM

21 TRANSFR # pp
Invoke key sequence described by value in parameter PP

22 SETEIA = nn
Set EIA RS-232 control line specified by value NN

23 TESTEIA = nn
Test EIA RS-232 control line specified by value NN

24 TESTFRM = nn
Test for type of frame indicated by value NN

25 TESTKEY = nn
Test for keyboard input indicated by value NN

26 BREAK # pp
Send BREAK for length of time specified in parameter PP

27*1 BCC: mm
Calculate and insert BCC for message MM

28*1 PROTOCOL
Enables customized BCC calculation for particular protocols and translation codes

29*1 BLOCK: mm
Compare frame to message buffer MM and count bit errors

30*1 CLEAR # pp
Set contents of parameter PP to zero

31*1 CALL→ss
Program execution continues at step SS after placing the number (SS+1) in the register.

32*1 RETURN # pp
Program execution continues at step number contained in parameter PP

33*1 OVERLAY # pp
Invoke transfer function xx, where xx is the contents of parameter PP

In addition to the Extended Instruction Set, the following instructions are resident in selected ROM packs.

34 PACKFRM: mm
Pack control field data into message mm, or, if mm = 0, unpack control field data from received HDLC/SDLC frame.

35 HEXCONV : mm
Convert an item in the register to the hexadecimal value of the item; add the hexadecimal character string to message mm.

36 AND # pp
AND the contents of the register with the value in parameter pp, then place the ANDed value in the register.

37 OR # pp
OR the contents of the register with the value in parameter pp; then place the ORed value in the register.

**1 Not in 834R01*

834R01 General Purpose ROM Pack

The 834R01 ROM Pack*1 simplifies and expands operation of the 834 Data Communications Tester for use with asynchronous systems.

The following capabilities are programmed into the 834R01 ROM Pack:

Sets up conditions for asynchronous operation upon instrument power up.

The addition of correspondence and baudot character decode tables.

Additional idle menu selections.

Split baud rate capability allows either the transmit or receive baud rate to be changed.

Basic printer tasks verify:

That characters are positioned and printed properly. Also evaluates DTR response and X-on, X-off feature.

Simulate and repeat modes (with and without trigger).

Correspondence code setup (sets the 834 to the most common correspondence setup).

Baudot code setup (sets up the 834 for the most common Baudot code setup).

Block asynchronous setup (sets up the 834 to operate in the block-asynchronous mode).

Graphic test patterns for calibrating screen attributes in Tektronix 4010 Series terminals.

Extended instruction set through the BREAK instruction (#26).

**1 Level 3 or higher 834 software required.*

834R02A
Bisynchronous (EBCDIC) ROM Pack

834R06
Bisynchronous (ASCII) ROM Pack

The 834R02A and 834R06 ROM Packs*1 extend and simplify the use of the 834 in exercising components of the IBM 3270 Information Display System family and compatible terminals manufactured by other companies.

The following capabilities are provided in an EBCDIC version in the 834R02A*1 and ASCII in the 834R06:

Frame Summaries to provide frame level mnemonic summary on a frame-by-frame basis. (This enables the user to quickly and easily step through data a frame at a time while viewing straight forward descriptions rather than sorting through long streams of data.)

Automated BCC checking and insertion

Preprogrammed common bisync messages

Terminal setup and status tests

Attribute Exercise Pattern for testing screen attributes and orders of a video display terminal.

Multiple alignment patterns for video displays

New line/End-of-message patterns for testing printers

Control Key Response test

Various utility programs

Extended instruction set, plus Hex conversion

The AND instruction, and the OR instruction

**1 Level 5 or higher 834 software required.*

OPTION 12

Option 12 (for the 834R02A, 834R06, 834R10 and 834R13 ROM packs) incorporates the software to support down loading of programs from a remote host to the 834. Option 12 also includes a logon application program specific to ATT requirements. Coupling between the 834 RS-232 port and transmission line will require a user supplied modem.

834R03A Link Test ROM Pack

The 834R03A ROM Pack*1 extends the Data Communications Link testing capability of the 834.

The following Bit Error Rate Test (BERT) patterns are provided in the 834R03A ROM Pack:

User defined (may be 4 to 3000 bytes in length)

2047-bit pseudo-random pattern

63-bit pseudo-random pattern

511-bit pseudo-random (CCITT V.25) pattern sent in block sizes of 511 bits instead of 1000

Continuous space

Continuous mark

Alternating spaces and marks

3 spaces alternating with 1 mark

1 space alternating with 3 marks

7 spaces alternating with 1 mark

1 space alternating with 7 marks

Additional test lengths:
- 10 kilobits
- 10 megabits
- Timed termination

Independent transmit and receive baud rates
Over and under baud rate deviation tests (±1, 2.5%)
Turn around delay measurement
Control line tests
Full and Half duplex ping-pong tests
Half duplex BERT
Bias distortion test
Gross start-stop distortion test
Individual start-stop distortion test
Isochronous distortion test
Extended Instruction set

¹ Level 4 or higher 834 software required.

834R04 HDLC/X.25 ROM Pack

The 834R04 ROM Pack*¹ expands the operational scope of the 834 when monitoring and simulating HDLC and X.25 packet switching networks and their components.

The following capabilities are included in the 834R04 ROM Pack:
- Frame-by-frame analysis of data exchanges
- Packet-by-packet analysis of data exchanges
- Construction of HDLC-formatted frames under applications control
- LAP and LAPB setup-shutdown tests
- Extended instruction set
- Packfram instruction
- Option 01 (Factory installed only) makes the 834R04 compatible with HDLC networks using Bisync Framing.

¹ Level 5 or higher 834 software required.

834R05
Extended Instruction Set ROM Pack

The 834R05 ROM Pack*¹ is for users with unique application requirements that cannot be fulfilled by the standard application programming included in other ROM Packs. The 834R05 contains the extended instruction set and program debug and edit functions. The remainder of the ROM Pack is reserved for user application ROMs.

The 834R05 reserves room for three user ROMs.

¹ Level 4 or higher 834 software required.

834R07 PARS/IPARS ROM Pack

The 834R07 ROM Pack*¹ expands the operation of the 834 Data Communications Tester for testing programmed airline reservation systems.

The following capabilities are included in the ROM Pack:
- SABRE translation
- Reversed Hexidecimal translation
- Inverted data capabilities
- Direct Poll — Continually sends a Go-Ahead message and looks for replies after each poll.
- 768 E-Pattern (64 X 12) for terminal alignment
- 960 E-Pattern (64 X 15) for terminal alignment
- 65 Character Print (64 X 12) "Stairstep" pattern
- Reset Terminal — Sends terminal reset command (3E HEX) to interchange unit to effect erasure of all terminal screens.
- Terminal Echo — Polls an interchange and when text message is received, echoes that message back to the originating terminal.
- Printer Test — tests new line function
- Terminal Simulation — Responds to direct polls, write, erase/write commands, and unsolicited message commands.
- ASCU Set-ups — For communicating to Agent Set Control Unit Equipment
- Extended Instruction Set

¹ Level 4 or higher 834 software required.

834R10 SDLC/SNA (FID2) ROM Pack

The 834R10 ROM Pack*¹ enhances the capabilities of the 834 when operating in an SDLC/SNA environment using format identifier type 2. This ROM Pack provides easy to read SDLC frame and SNA command summaries. This allows quick and straightforward analysis of data transactions.

The following capabilities are included in the 834R10 ROM Pack:
- Attribute tests for 3274 and 3276 displays
- Display alignment pattern
- New-Line/End-of-Message pattern for testing printers attached to 3274s and 3276s.
- Control Key Response Test
- Extended Instruction Set, plus
- HEX conversion
- AND instruction
- OR instruction

¹ Level 5 or higher 834 software required.

834R11 Extended Monitor ROM Pack

The 834R11 ROM Pack*¹ implements more powerful monitoring functions. It allows the recognition of events to cause programmable actions rather than simply triggering the 834. Using event-action pairs provides the mechanism for manipulating counters and timers that facilitate statistical analysis of interactions or events within a network as well as complex triggering.

There are three event-action pairs available with this ROM Pack plus a timeout-action pair that activates when an event does not occur within a specified time.

The 834R11 does not require the extended instruction set.

834R11 ROM Pack event selections:
- DCE Messages with or without masking
- DTE Messages with or without masking
- Error
- Selected Control line change

834R11 ROM Pack action selections:
- Trigger the 834
- Decrement or increment specified counter
- Start interval timer
- Enable event-action pairs
- Disable all actions except Enable

¹ Level 5 or higher 834 software required.

NEW 834R13
SDLC/SNA (FID 3) ROM Pack

The 834R13 ROM Pack enhances the capabilities of the 834 when operating in an SDLC/SNA environment using format identifier Type 3. This ROM Pack provides easy-to-read SDLC frame and SNA command summaries. This allows quick and straightforward analysis of data transactions.

The following capabilities are included in the 834R13 ROM Pack:
- Attribute tests for 3271 Control Unit Models 11 and 12, 3275 Display Station Models 11 and 12.
- Display alignment pattern
- New-Line/End-of-Message pattern for testing printers attached to 3271s and 3275s
- Control Key Response Test
- Extended Instruction Set, plus
- HEX conversion instruction
- AND instruction
- OR instruction

¹ Level 5 or higher 834 software required.

ORDERING INFORMATION

834R01 General Purpose ROM Pack	**$280**
834R02A Bisynchronous ROM Pack (EBCDIC)	**$350**
Option 12	**$60**
834R03A Link Test ROM Pack	**$370**
834R04 HDLC/X.25 ROM Pack	**$450**
Option 01 — Bisynchronous Framing	**+$50**
834R05 Extended Instruction Set ROM Pack	**$175**
834R06 Bisynchronous ROM Pack (ASCII)	**$350**
Option 12	**+$60**
834R07 PARS/IPARS ROM Pack	**$375**
834R10 SDLC/SNA (FID2) ROM Pack	**$450**
Option 12	**$60**
834R11 Extended Monitor ROM Pack	**$425**
834R13 SDLC/SNA (FID 3) ROM Pack	**$450**
Option 12 — Download with ATT Application	**+$60**

Additional information available in the 834 Selection Guide (request number 35W-4922). Request copies at your local sales office or via the return card in this catlog.

851

Designed for Digital Field Service Applications

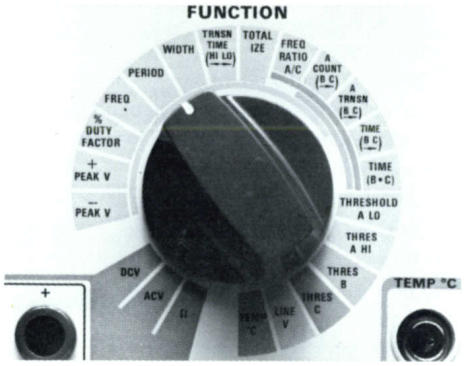
Small and Lightweight

The 851 Digital Tester is an easy-to-operate first-line service tool used to troubleshoot and maintain a wide range of digital equipment.

With this portable digital tester, weighing only 6 kg (13 lb), a first-line service engineer can make many of the same measurements that now require an oscilloscope, DMM, counter, timer, logic probe, thermometer and special purpose test equipment.

One knob lets you dial 22 functions to perform a wide variety of tests and measurements. Eleven functions measure timing, two register plus and minus peak voltages, three carry out DMM measurements through separate leads and one reads line voltage at the outlet. Another function allows you to take temperature readings with an optional temperature probe. The 851 also measures its four input thresholds to adjust to the logic levels of the equipment being serviced.

All functions are completely autoranging and the indicator lights tell you exactly what range is being used.



CHARACTERISTICS

INPUTS

(ACV, DCV, Ω)

Resistance and Capacitance — 10 MΩ ±1% and ≈100 pF. Red to black terminal. (Volts only.)

Maximum Safe Input Voltage — ±500 V (peak) ACV/DCV (≤1 kHz).

Resistance Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ, and 50 MΩ.

AC VOLTS

(Average responding RMS calibrated for sinewave.)

Ranges — 2 V, 20 V, 200 V, and 350 V.

Accuracy — 2 V and 20 V: ±0.5% or reading ±4 counts, 40 Hz to 1 kHz. ±2% of reading ±4 counts, 1 kHz to 25 kHz. >9% full scale. 200 V and 350 V: ±0.5% of reading ±4 counts, 40 Hz to 1 kHz. Extended Temperature Range: Add ±0.2%.

DC VOLTS

Ranges — 2 V, 20 V, 200 V, and 500 V.

Accuracy — 2 V, 20 V and 200 V: ±0.1% of reading ±3 counts. 500 V: ±0.15% of reading ±3 counts. Extended Temperature Range: Add ±0.05%.

LINE VOLTAGE

Range — 90 to 132 V and 180 to 250 V.

Accuracy — ±3% of reading.

TEMPERATURE

Range — −55°C to +150°C.

Accuracy — ±2°C (0.01° resolution). Extended Temperature Range: Add ±1°C.

INPUTS

(Three probes; one for each channel A, B, C.)

Resistance and Capacitance — 10 MΩ and ≈12 pF.

Maximum Safe Input Voltage — ±500 V at probe tip (≤50 kHz).

Threshold Levels — Variable (4 controls) Range: ±30 V. Setability: ±10 mV.

TTL (Nominal, in Detent Position) — Input A: LO is +0.7 V; HI is +2.1 V. Input B and C: +1.4 V.

Input Filter (Narrow Pulse Rejection) — Maximum input rep rate for pulse rejection = 20 MHz.

Range — Off and 50 ns ±20% to >300 ns. Channel to Channel Delay Mismatch: <100% of setting.

POSITIVE AND NEGATIVE PEAK VOLTS

Range — ±30 V.

Accuracy — ±2% of reading ±3% of p-p signal ±90 mV. Maximum Time Between Recurrent Peaks: 25 ms. Peak amplitude must be maintained for at least 25 ns. Extended Temperature Range: Add ±1% of reading ±1% of p-p signal ±10 mV.

FREQUENCY

Ranges — 100 kHz (1 Hz resolution), 1 MHz, 10 MHz, and 35 MHz.

Accuracy — ±0.005% of reading ±1 count.

TIME MEASUREMENTS

(Period, pulse width, transition time, time interval, and coincidence time.)

Ranges — 1 ms (10 ns resolution), 10 ms, 100 ms, 1 s, and 10 s.

Minimum Time Interval — 20 ns.

Accuracy — ±0.005% of reading ±1 count ± Trigger Error.

COUNTING

(Totalize, frequency ratio, events count, and transitions count.)

Range — 0 to 99,999.

Maximum Input Frequency — 35 MHz (except 17.5 MHz for transition counting).

Accuracy — ±1 count, ±A Input event or transition frequency multiplied by the Time Interval Trigger Error.

DUTY FACTOR

Range — 0% to 100%.

Input Frequency Range — 40 Hz to 10 MHz.

Minimum Pulse Width (HI and LO Portions) — 50 ns.

READOUT

Type — Five digits, fully buffered seven segment, 0.5 in LEDs.

Polarity Indication — + for positive readings, − for negative readings.

Overrange Indication — Display flashes.

Range Indicators — LEDs show function ranges in Ω, kΩ, MΩ, MHz, kHz, ms, μs and V.

Logic State Indicators — Red, yellow, and green LEDs show valid and invalid logic state inputs for CH A. Red and green LEDs show logic states above or below the threshold set for CH B and C. Any state change indication is sustained long enough to be visible.

Threshold Lock Indicator (LO > HI) — Red LED indicates when CH A LO and HI thresholds are locked together (LO threshold setting is higher than the HI setting).

POWER REQUIREMENTS

Line Voltage Range — 90 to 132 V or 180 to 250 V.

Frequency — 48 Hz to 440 Hz.

Power Consumption — 57 W maximum.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating: +15°C to +40°C. Nonoperating: −40°C to +75°C. Extended Operating Range: +5°C to +50°C.

Altitude — Operating: To 3048 m (10,000 ft). Nonoperating: To 10 665 m (35,000 ft).

Vibration — Operating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. After cycle vibration in each axis, hold frequency steady at 55 Hz for 10 minutes. All major resonances must be above 55 Hz.

Humidity — To 90% at 30°C Tektronix Test Method #1 90% relative humidity at 30°C for 4 hours.

Shock — Two shocks at 30 g's, ½ sine, 11 ms duration, each direction along each major axis. Total of 12 shocks.

EMC — Reference Mil Standard 461A-462 susceptibility as specified. Conducted emission, relax 10 dB. Radiated emission, relax 15 dB <100 MHz and relax 25 dB ≥100 MHz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	330	13.0
Height	310	13.0
Depth	180	7.0
Weight≈	**kg**	**lb**
Net	6.0	13.0

INCLUDED ACCESSORIES

Three signal probes (010-0280-00), two DMM probes (012-0732-00); manual.

ORDERING INFORMATION

851 Digital Tester **$3,220**

Option 01 — With Temperature Probe ..... **+$160**

OPTIONAL ACCESSORIES

Temperature Probe — Order 010-6430-00 ..... **$210**

Rain Jacket — Order 016-0639-00 ..... **$15**

NEW

TELEVISION PRODUCTS

1740 Waveform/Vector Monitors

Two Instruments in One

Optional Dc Power Capability

Bright CRT Display

R-Y (V Axis) Mode

VITS Monitoring

RGB/YRGB Display Capability

Remote Control Capability

Available in NTSC, PAL, and PAL-M

The 1740 Series represents a significant addition to the capability of the Tektronix television signal monitor family of products. Like the 528A and 1420 Series products, which it complements, the 1740 Series provides all the basic waveform monitoring and vectorscope functions, but in a single, compact package. In addition, the 1740 Series adds dc power operation (optionally), single line vertical interval display which is internally preset, an R-Y/sweep mode for differential phase measurements, and remote control of waveform/vector mode and most of the front panel sweep and vertical amplifier response functions.

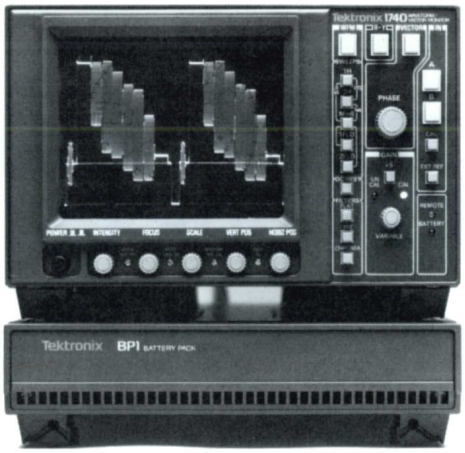
The 1740 Series monitors are half-rack width instruments. They are intended for use where space and power consumption and/or portability are prime considerations and where waveform and vector displays are not simultaneously required.

Typical applications include video signal monitoring in VTR bridges, camera control units, production switcher consoles, and in mobile vans and field productions.

CONTENTS

1740 Waveform/Vector Monitors 160
110-S Synchronizer 162
1910 NTSC Digital Generator/Insertor 164
1980 Automatic Video Measurement Set 168
380/381 Video Test Monitors 175
1480 Series Video Waveform Monitors 177
528A Video Waveform Monitor 179
1420 Series Video Monitoring Vectorscopes 179
520A Series Vectorscopes 180
650HR Series Color Picture Monitors 182
690SR Television Color Monitor 185
NTSC Signal Generator Selection Guide . 188
1410 Series Test Signal Generators 189
1470/1474 NTSC Generators 196
143 SECAM Test Signal Generator 197
148 PAL Test Signal Generator 198
147A NTSC Generator 200
1430 Random Noise Measurement Set 201
1440 Automatic Video Corrector 202
1450 Series Television Demodulators 203
Calibration Fixtures 206

NEW



Optional Dc Power Capability

Two instrument options provide a dc Input for powering the monitor from a 12 volt dc power source. Option 07 provides the dc capability. Option 11 provides the dc capability and includes a portable case and the BP1 Battery Pack as the power source. The BP1 quickly and securely mounts to the bottom of the portable case. Total package weight of the instrument with the BP1 mounted is approximately 13.6 kg (30 lb).

A 1740 Series instrument will operate from a BP1 for at least two hours before recharging is required. A fast charger is available as an optional accessory. Spare BP1 Battery Packs are also available as optional accessories.

Bright CRT Display

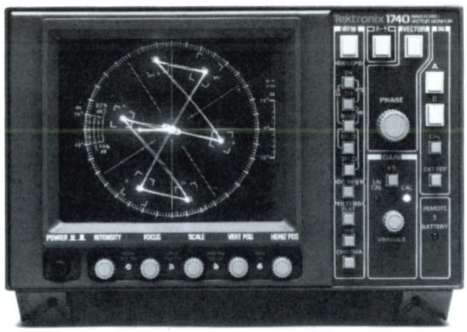
The bright CRT display permits use of the 1740 Series in high ambient light conditions, such as those encountered in field production applications. Brightness remains high in the 1 and 0.5 μs magnified sweep speeds, thus enhancing the 1740's use in system phasing applications. The internal waveform graticule and the external vector graticule are independently illuminated. A parallax free dual internal graticule, including both the waveform and vector graticules, is available (Option 06).

R-Y (V AXIS) Mode

The demodulated chrominance may be displayed with a horizontal sweep using the R-Y mode for NTSC signals or the V AXIS mode for PAL and PAL-M signals. When the burst is set properly in the vector mode, the R-Y mode displays the chrominance demodulated on the R-Y axis (V axis in PAL systems). There are differential phase markings on the right side of the vector graticule that are calibrated for use in this mode. Different sweep speeds may be used to examine differential phase as a function of time.

VITS Monitoring

VITS (Vertical Interval Test Signals) or ITS (Insertion Test Signals) can be monitored in all modes. Each instrument model is internally set for a particular line. The 1740 is set to display line 19, usually occupied by the VIRS (Vertical Interval Reference Signal). The 1741 is set to line 17/330, and the 1742 to line 17/280. The 1740 may be reset for any line from 6 through 36, the 1741 from line 3/316 through 33/346, and the 1742 from line 3/266 through 33/296.



1740 (NTSC Vector Display)

RGB/YRGB Display

Facilities for a parade display of camera RGB signals are included in all 1740 Series instruments. The monitor's REMOTE connector accepts the required enable and 3-step staircase signals from the camera. An internal jumper change permits display of a YRGB parade signal.

Remote Control Capability

Remote control of input channel selection, mode, sweep speeds, and vertical amplifier filters is available through a rear panel connector. The remote function is useful for VTR applications.

Available in NSTC, PAL, and PAL-M

The 1740 Series Waveform/Vector Monitors includes instruments for each of three color television systems: 1740 NTSC, 1741 PAL,1742 PAL-M.

Measurement Facilities

In addition to the measurements usually associated with waveform and vector monitors, and those provided by the R-Y (V Axis) mode, a 1740 Series instrument may be used for system phasing, horizontal blanking measurements, and for limited accuracy differential gain. There are also graticule markings for line tilt measurements.

ELECTRICAL CHARACTERISTICS

VERTICAL WAVEFORM MODE

Deflection Factor — 1740: 140 IRE display within 1% with 1 V input.
1741/1742: 1 V display within 1% with 1 V input.

Variable Gain Range — 1740: Input signals between 0.7 V and 2 V can be adjusted to 140 IRE display.
1741/1742: Input signals between 0.7 V and 2 V can be adjusted to 1 V display.

Maximum Absolute Input Level — ±2 V (dc + peak ac).

Video Input Return Loss — At least 40 dB from 50 kHz to 6 MHz.

FREQUENCY RESPONSE

FLAT — ±2% from 50 kHz to 6 MHz. ±5% from 6 MHz to 8 MHz.

IRE (1740) — Conforms to IEEE Standard 205. Response at 15 kHz does not vary between FLAT and IRE by more than 1%.

LUM (1741/1742) — <3 dB down at 1 MHz, >40 dB down at 4.43 MHz, response at 15 kHz does not vary between FLAT and LUM by more than 1%.

CHROMA (1740/1742) — Response at 3.58 MHz does not vary between FLAT and CHROMA by more than 1%.
Lower: −3 dB point at 2.83 MHz to ±0.15 MHz.
Upper: −3 dB point at 4.33 MHz to ±0.15 MHz.
Attenuation: at 7.2 MHz to >25 dB.

CHROMA (1741) — Response at 4.43 MHz does not vary between FLAT and CHROMA by more than 1%.
Lower: −3 dB point at 3.68 MHz to ±0.15 MHz.
Upper: −3 dB point at 5.18 MHz to ±0.15 MHz.
Attenuation: at 8.9 MHz to >25 dB.

RESPONSE DISTORTIONS

Preshoot — 1% or less.

Pulse-to-Bar Ratio — 0.99:1 to 1.01:1.

Overshoot — 2% or less.

Ringing — 2% or less.

Tilt (Field Rate Squarewave, Vertical Window, or 25 μs Bar) — 1% or less.

Differential Gain — Displayed differential gain is 1% or less with 10% to 90% APL changes.

VIDEO OUTPUT

Frequency Response — 50 kHz to 6 MHz, within 3% of response at 50 kHz.

Dc Level on Output — 0.5 V or less into 75 Ω load.

Output Impedance — 75 Ω.

Return Loss — At least 30 dB, 50 kHz to 6 MHz.

DC RESTORATION

Dc Restorer Clamp Time — Back porch (Internally selectable to sync tip).

Low-Frequency Response at 60 Hz — (Attenuation of 60 Hz or input signal) 20% or less.

Blanking Level Shift with APL Change — 1740: APL changes from 50% to either 10% or 90% will cause blanking level shift of 1 IRE unit or less.
1741/1742: APL changes from 50% to either 10% or 90% will cause blanking level shift of 7.2 mV or less.

CALIBRATOR SIGNAL

Frequency — 100 kHz, ±0.1 kHz. Synchronizes in 2H and 1H sweep, providing reference for sweep and magnifier calibration.

Amplitude — 1 V display within 0.5%.

HORIZONTAL DEFLECTION SYSTEM

Sweep — Sweep occurs in all Horizontal mode settings with or without synchronization.

1FLD Sweep Repetition Rate — Equal to field rate of applied video or external sync.

2FLD Sweep Repetition Rate — Equal to frame rate of applied video or external sync.

1H Sweep Repetition Rate — Equal to line rate of applied video or external sync.

2H Sweep Repetition Rate — Equal to half line rate of applied video or external sync.

Timing Accuracy — 1 μs/div sweep within 2%. 0.5 μs/div sweep within 3%.

Linearity — 1 μs/div and 0.5 μs/div within 2%.

SYNCHRONIZATION REQUIREMENTS

Internal References — 1740: Composite video or black burst with sync and burst amplitudes 40 IRE to ±6 dB.
1741/1742: Composite video or black burst with sync and burst amplitudes 300 mV to ±6 dB.

External References — Waveform Mode: Sync amplitude between 143 mV and 4 V will synchronize sweeps.

Vector Mode — 1740: Composite video or black burst with sync and burst amplitudes 40 IRE to ±6 dB.
1741/1742: Composite video or black burst with sync and burst amplitudes 300 mV to ±6 dB.

NEW

1740 (NTSC) VITS Display of the VIR Signal

1740 (NTSC) R-Y Display of Modulated Ramp Signal

EXTERNAL REFERENCES INPUT

Dc Input Impedance — >15 kΩ.

Return Loss — At least 40 db from 50 kHz to 6 MHz.

RGB/YRGB MODE

Will display either a 3- or 4-step RGB/YRGB display.

Staircase Amplitude — A 10 V input will result in a horizontal display of 9 divisions ±1.4 major divisions.

Maximum Operating Staircase Signal Voltage — 12 V p-p ac component. Signal voltage not to exceed ±12 Vdc + peak ac.

VECTOR MODE

Chrominance Bandwidth — Upper: −3 dB point Fsc +500 kHz to ±100 kHz.
Lower: −3 dB point Fsc −500 kHz to ±100 kHz.

Vector Phase Accuracy — Within 1.25°C.

Vector Gain Accuracy — 1740: Within 1.25 IRE.
1741/1742: Within 1.25%.

Quadrature Phasing — Within 0.5°C.

SUBCARRIER REGENERATOR

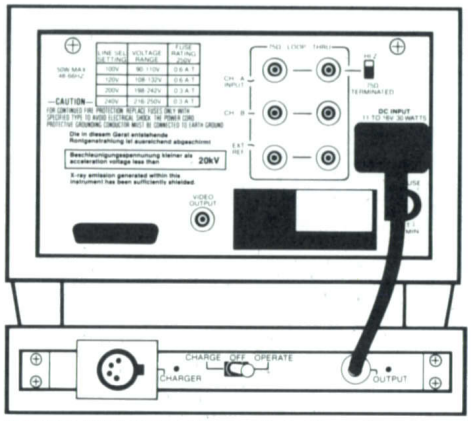
Pull-In Range — 1740: Within 50 Hz of Fsc.
1741/1742: Within 10 Hz of Fsc.

Phase Shift with Subcarrier Frequency Change — 1740: Within 0.5°C from Fsc to (Fsc +50 Hz), or Fsc to (Fsc −50 Hz).
1741/1742: Within 0.5°C from Fsc to (Fsc +10 Hz), of Fsc to (Fsc −10 Hz).

Phase Shift with Burst Amplitude Change — Within 2°C from nominal burst amplitude to ±6 dB.

Phase Shift with Reference Switched Between Internal and External References — Within 0.5°C.

Phase Shift with Input Channel Change — Within 0.5°C.



Rear Panel With Optional Battery Pack Attached

Phase Shift with X5 Gain — Within 2°C.

Phase Shift with Variable Gain — Within 1°C as gain is varied from +3 dB to −6 dB.

Phase Control Range — 360°C continuous rotation.

DISPLAY CHARACTERISTICS

Differential Phase — Within 1°C.

Differential Gain — Within 1%.

Variable Gain Range — 1740: Input subcarrier signals between 28 IRE and 140 IRE can be adjusted to normal burst vector length.
1741/1742: Input carrier signals between 210 mV and 1.0 V can be adjusted to normal burst vector length.

CRT DISPLAY

CRT Viewing Area — 80 mm x 100 mm.

Accelerating Potential — Nominally 15 kV.

GRATICULE

Waveform — Internal, variable illumination.

Vector — External, variable illumination. Illuminated with VECTOR or R-Y mode selected.

POWER SOURCE

Mains Voltage Ranges — 100 V (90-100 V); 120 V (108-132 V); 220 V (200-242 V); 240 V (218-250 V).

Mains Frequency Range — 48 Hz to 66 Hz.

Power Consumption — 50 W max in ac. 30 W nom in dc.

DC BATTERY OPERATION (OPTIONAL 07)

Voltage Input Range — 11 V to 16 V.

Over Voltage and Polarity Reversal Protection — Fuse blows if >20 Vdc or opposite polarity is applied to the dc INPUT.

Under Voltage Protection — Instrument shuts down when battery voltage (under load) is below 9 V.

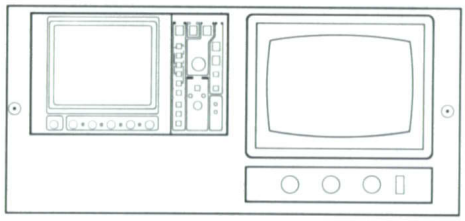
Battery Current — 3.5 A or less at 12 V.

ENVIRONMENTAL CHARACTERISTICS

Temperature — Operating: 0°C to +50°C.
Nonoperating: −55°C to +75°C.
Altitude — Operating: 4500 m (15,000 ft).
Nonoperating: 15 000 m (50,000 ft).

CERTIFICATION

Safety/EMI — UL 1244.



1740 and Picture Monitor Rack Mounted Using 014-0020-00, Mounting Cradle.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	216	8.5
Height	133	5.25
Depth	460	18.12
Weight	**kg**	**lb**
Net	8.2	18.8
Battery Pack	13.6	30.0

INCLUDED ACCESSORIES

Power cable assembly (161-0066-00); 250 V, 0.3 A fuse (159-0029-00); 250 V, 0.6 A fuse (159-0043-00); clear filter (378-0219-00); female remote connector (131-0569-00); remote connector housing (200-1667-00); remote connector strain relief (358-0314-00); instruction manual 1740/1741/1742.

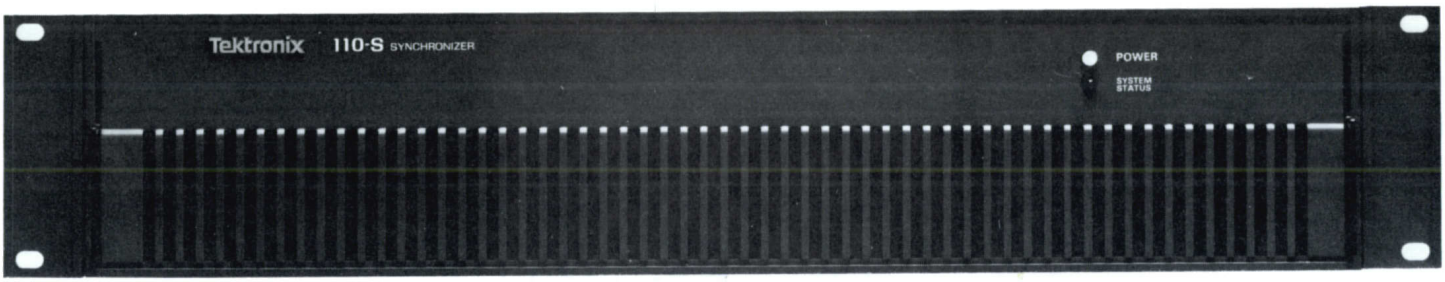
ORDERING INFORMATION

1740 Waveform/Vector Monitor (For NTSC system applications **$4,000**
1741 Waveform/Vector Monitor (For PAL system applications **$4,000**
1742 Waveform/Vector Monitor (For PAL-M system applications **$4,400**
Option 01 — (Without the case) ..... −$30
Option 02 — (Adds a portable carrying case with handle) ..... +$70
Option 06 — (Dual internal graticule, waveform and vector) ..... +$30
Option 07 — (Adds Dc power operation capability) ..... +$60
Option 11 — (Portable carrying case, Dc power operation, and a BP1 battery pack) ..... +$650

OPTION ACCESSORIES

Battery Pack — BP1 ..... **$550**
Battery Pack Charger — Order 119-1682-00 ..... **$700**
Camera — C5C Option 02 ..... −$20
Viewing Hood — Order 016-0475-00 ..... **$8.25**
Extender Board — Order 670-7980-00 ..... **$47**
Extender Cable — Order 067-0709-00 ..... **$41**
Deflection Leads Extender Cables (4) — Order 196-0939-00 ..... **$6.00**
External Photographic Graticules — **Flip Stand, Cabinet** — Order 348-0618-01 ..... **$4.75**
Side-by-side Rack Adaptor (1424 etc) — Order 016-0115-02 ..... **$180**
Blank Panel for Rack Adaptor — Order 016-0116-00 ... **$42**
Mounting Cradle. An Assembly with Associated Bezel and Mounting Brackets Allows the 1740 to be Mounted Beside a 9-inch Picture Monitor in a Standard 19-inch Rack — Order 014-0020-00 ..... **$225**
Bezel and Brackets (Left Side Mounting of 1740) — Order 014-0038-00 ..... **$315**
Bezel and Brackets (Right Side Mounting of 1740) — Order 014-0037-00 ..... **$315**

NEW



110-S

True 10-Bit Accuracy and Resolution

Tracks Signals into the Noise

Adaptive Decoding-Minimizes Picture Shifts while Preserving Horizontal and Vertical Detail, Provides Exceptionally High Quality Picture Freeze

Adaptive Clamping-Minimizes Streaking on Noisy Signals

Digitally Precise Sync and Burst Insertion

Passes the Vertical Interval

Processing Amplifier

Optional Four-Field Memory for the Highest Picture Quality

Precalibrated Boards in Modular Design

The 110-S Synchronizer is a high quality 10-bit, 4 X fsc synchronizer. The 10-bit architecture, adaptive clamping combine to provide a synchronizer that performs well on noisy signals, minimizes horizontal picture shifts, and is virtually transparent to the processed signal.

10-Bit Precision

A Tektronix-designed 10-bit digitizer and a sampling rate of four times the subcarrier frequency result in negligible quantizing errors, low differential gain and phase, and a flat frequency response. Compared to 8-bit synchronizers, the 110-S has four times the accuracy and resolution. The resulting transparency to the video signal allows cascading of 110-S synchronizers in the signal path with minimum signal degradation.

Tracking Into Noise

When noise from a fading ENG microwave feed or static interference degrades the S/N ratio, the 110-S keeps tracking the signal. If the original sync and burst are clean, they may be pressed with the original signal. Noisy sync and burst are replaced with precise, digitally-generated RS-170A sync and burst. The 110-S can be configured to track into the noise, freeze field, or go to black upon loss of the incoming signal. As noise increases, an adaptive clamp slows down to prevent horizontal streaking. Yet the clamp still responds quickly to hot switches.

Four-Field Memory (Optional)

Four-field memory allows display of full color-frames with correct SCH phase and without decoder artifacts. Four-field storage also enables accurate synchronization without the 140 ns horizontal shift caused by frame overlapping. Freeze frames of one, two, or for maximum resolution, four fields may be selected with the 110-S four-field option.

Adaptive Signal Decoding

Standard on the 110-S is the adaptive decoder which monitors the incoming video signal and reacts to signal characteristics in an optimal manner. Vertical correlation of the picture information (for example a flag pole) allows chrominance/luminance separation to be done by a 3-line comb filter, thus preserving the fine detail in the picture. Absence of vertical correlation in the picture causes the notch decoder to be activated, thus preserving vertical chroma resolution. On the two-field version of the 110-S, the adaptive decoder eliminates the 140 ns horizontal shift.

Processing Amplifier With Remote Control

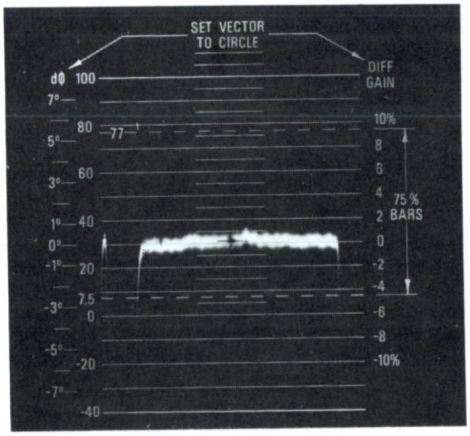
Signal level, setup, chroma gain and hue can be adjusted either inside the 110-S or via rear-panel remote control connector.

Digital Test Ports

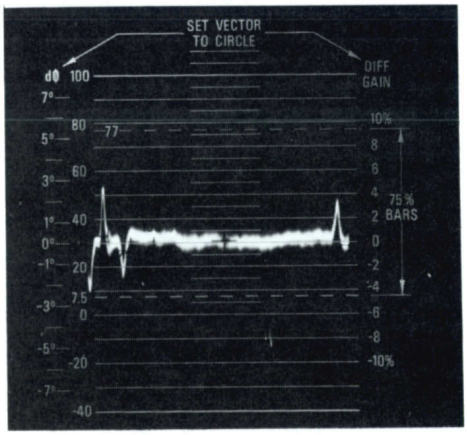
A Digital Test input port allows use of a digital signal from any of the Tektronix 1900 Series test signal generators to test the decoder and digital-to-analog converter. A Digital Output port enables analysis of the input video signal after it has been digitized by the analog-to-digital converter and processed through memory. This data can drive the DAC in a 1900 Series generator.

Reliable Operation

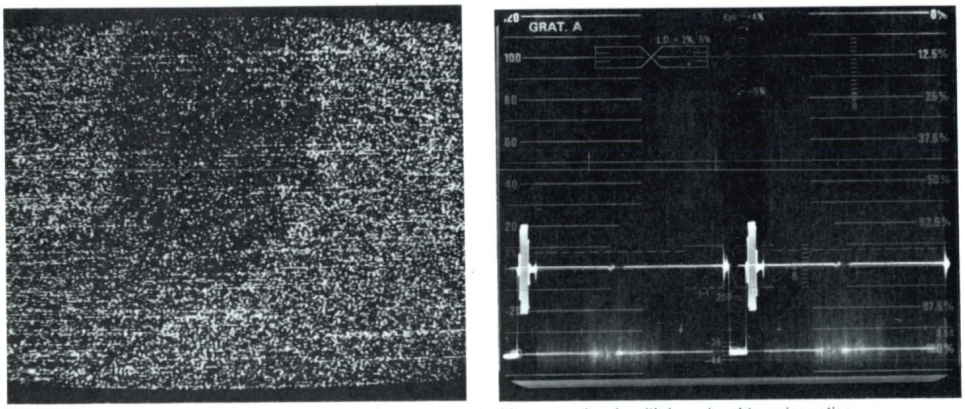
110-S reliability is assured by using high quality components, preconditioned IC's and two-piece connectors. Dual adaptive cooling fans provide overheating protection. The infrequent task of troubleshooting becomes fast and simple with modular, front-panel loaded circuitry designed so that the 110-S can be repaired without removing it from the rack. Factory precalibration of boards allows them to be replaced without disturbing the calibration of the synchronizer. Built-in diagnostics and input signal condition monitors continually check system status indicating possible problems. Memory error concealment allows in-service compensation of a memory fault, with remaining accuracy and resolution still better than 8-bit synchronizers. The 110-S automatically bypasses the signal when line power is lost.



110-S Differential Gain

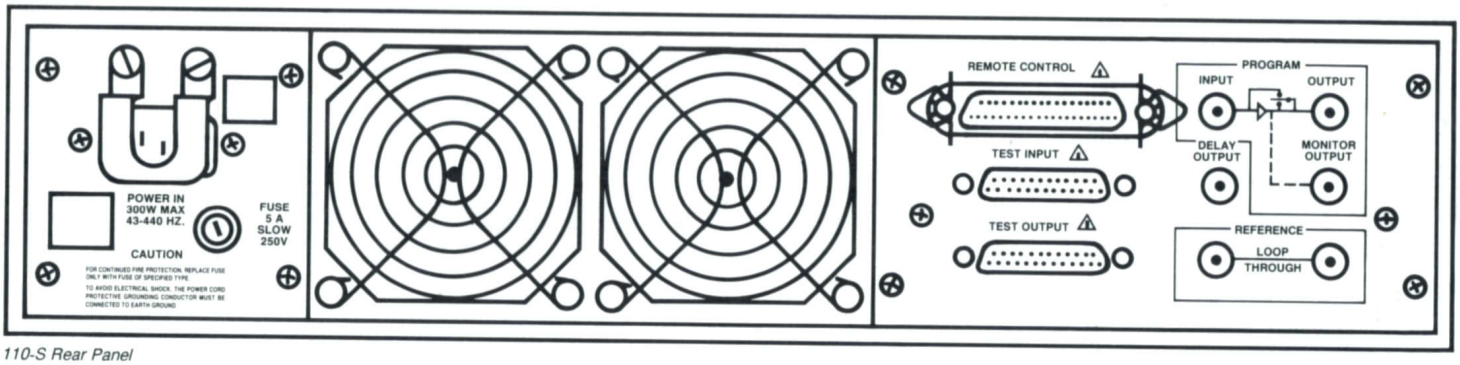


110-S Differential Phase

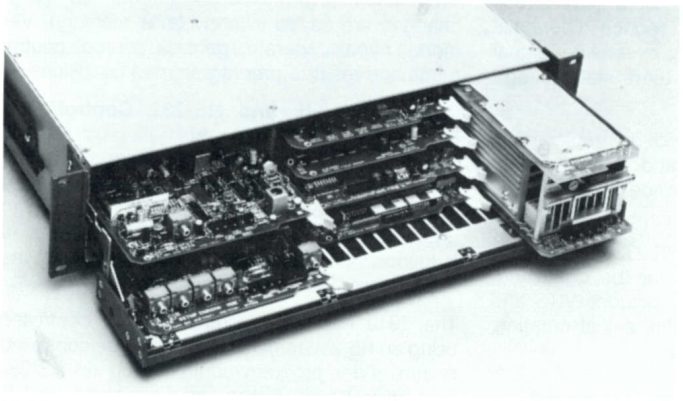


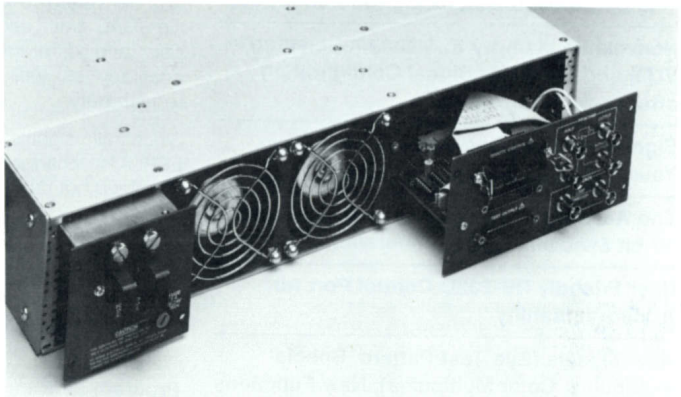
High genlock noise immunity prevents accidental freezes on noise hits or on signals with low signal to noise ratios.

NTSC SYNCHRONIZER



110-S Rear Panel





Modular construction and board exchange speed repair and minimize down time.

Audio Delay

An Audio Delay control port allows automatic audio-video delay correction when used with an audio delay unit.

Quantizing Error Included in Specifications

The industry has neglected the effects of quantizing error on synchronizer product specifications. The following 110-S specifications, however, include quantizing error for a modulated ramp with 40 IRE subcarrier.

CHARACTERISTICS

Digital Sampling — 10 bits at 14.3 MHz (1024 levels at 4 times NTSC Subcarrier).

ELECTRICAL

PROGRAM CHANNEL

Gain — Program Output: Unity ±1%.

Frequency Response — ±1% to 4.2 MHz.

Signal to Noise Ratio — >60 dB.

Chrominance/Luminance Gain Error — <1%.

Chrominance/Luminance Delay Error — <10 ns.

Differential Gain — <1%.

Differential Phase — <1°.

2T Pulse K Factor — 0.5%.

2T Pulse to Bar Ratio Error — <1%.

Short Time Distortion — <1%.

Line Time Distortion — <0.5%.

Field Time Distortion — <0.5%.

PROCESSING AMPLIFIER

Input Gain Range — ±3 dB.

Output Gain Range — ±3 dB.

Setup Range — ±10 IRE.

Hue Adjustment Range — ±20°.

Chrominance Gain Range — ±3 dB.

Signal Correction Timing — Horizontal Blanking: 10.2, 10.7 or 10.9 μs (selectable). Vertical Blanking: Start of field through line 21.

Sync and Burst Insertion Timing — Horizontal Insertion: 10.2, 10.7 or 10.9 μs (selectable). Vertical Insertion: Start of field through line 9.

Sync and Burst Insertion Amplitude Accuracy — ±1 IRE.

VITS Deletion Timing — Vertical Timing: Line 10 through line 14 (selectable).

ADAPTIVE CLAMP

The adaptive clamp has 32 dB hum rejection in the absence of noise other than hum, and reduces hum rejection in the presence of other noise in order to minimize clamp streaking.

Clamp Speed — Slow: (<20 dB S/N)*1. Settling Time: Within 5 IRE in 30 lines or more. Medium: (<35 dB S/N)*1. Settling Time: Within 5 IRE in 10 to 30 lines. Fast: (>35 dB S/N)*1. Settling Time: Within 5 IRE in 2 to 3 lines.

**1 Approximate signal to noise ratio.*

CHROMINANCE DECODER

Video Signal Filtering Modes — Pass: Signal unaltered. Comb: Chrominance inverted using 3-line comb filter. Burst is comb decoded. Notch: Chrominance inverted using 9-point transversal notch filter. VITS are notch decoded. Adaptive: Chrominance inverted using combination of notch and comb filters.

SYNCHRONIZER TIMING

Output Timing Range — Horizontal: 13.41 μs advance to 4.40 μs delay. Vertical: Two lines advance to 1 line delay.

POWER SUPPLY

Line Voltage Range — 90 V ac to 132 V ac; 180 V ac to 250 V ac.

Peak Input Power — 300 W maximum.

Typical Power — 240 W.

ENVIRONMENTAL CHARACTERISTICS

Temperature — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	480	19.0
Height	89	3.5
Depth	510	20.1
Depth (Rackmount)	491	19.4
Weight	**kg**	**lb**
Net	32.7	14.8

Remote Control Interface Functions — Remote Bypass, Manual Freeze, Freeze Field or Frame, Freeze Four Field, Enable Auto Freeze, Inhibit Decode, Inhibit Sync and Burst Insertion, External Test Data Enable, (Digital Input Port), Status Indicator, Power LED, System Status LED, Proc Amp Active LED, Bypass LED, Hue Control, Setup Level, Chroma Level, Input Gain (ADC), Output Gain (DAC).

INCLUDED ACCESSORIES

Power Cord (161-0066-00); remote plug 36-pin unwired connector with shell (131-0293-00); one set of rack slides (351-0636-00); circuit board extender (670-7754-00); operators manual; service manual.

ORDERING INFORMATION

110-S Synchronizer **$14,250**

Option 01 — Two-Field Memory Notch Decoder .... **−$1,250**

Otpion 05 — Includes Remote Control Unit ..... **+$500**

Option 10 — Four-Field Memory Adaptive Decoder . **+$4,000**

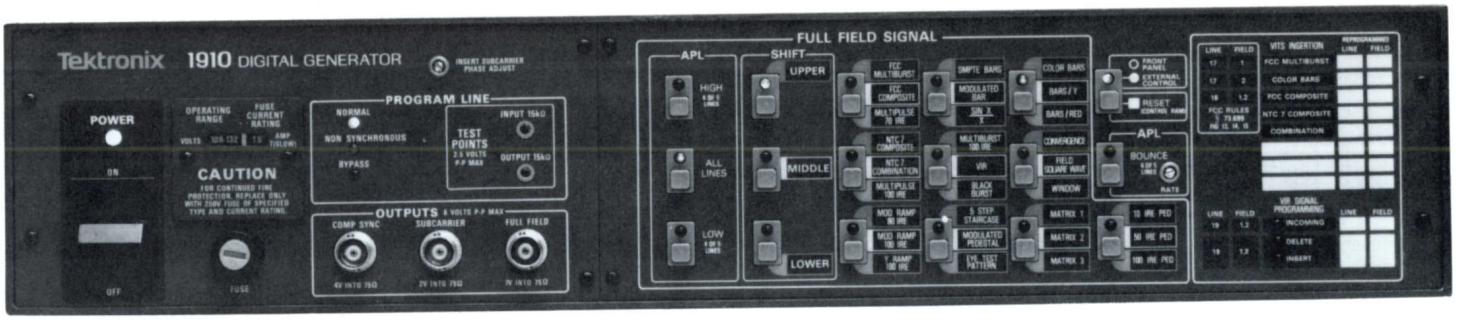
Option 11 — Four-Field Memory Notch Decoder .... **+$2,750**

OPTIONAL ACCESSORIES

Remote Control Unit — Order 015-0462-00 ..... **$500**

Spare Parts Kit — Order 020-0990-00 ..... **$1,255**

NEW



1910 Digital Generator

Four External VITS Inputs for Insertion of Teletext, Closed Captioning, Source ID, etc.

Nonvolatile Memory to Maintain Selected VITS and Full Field Signal Configuration after Power Interruption

Signal Stored in Replaceable PROMs so Your 1910 won't Become Obsolete

The Accuracy and Stability of an all-Digital 10-bit Sync and Signal Generation (RS-170A)

User Friendly RS-232C Control Port for Added Versatility

New Signals (Eye Test Pattern, Special Multipulse, Color Multipulse), New Functions (VITS Sequence, Field Sequence and More

The 1910 Digital Generator is a state-of-the-art test signal generator designed for performance testing of NTSC video systems and equipment. With the 1910, Tektronix has combined the capabilities of its 1900 Series test generators, including their signal stability and accurate SCH phasing. The 1910 is especially suited where high accuracy and stability are required. It is also a VITS inserter (internal and external) with a full complement of signals that allow testing in studio, transmitter, production or research environments. Four external VITS inputs permit insertion of signals such as videotext, closed captioning, source ID, and other similar sources. These four inputs may be converted to four pulse outputs for use in a production environment.

External interfacing of the 1910 is controlled by an internal microprocessor and its nonvolatile memory. Test signals are stored as 10-bit digital words and converted to analog form by a 10-bit precision DAC (with deglitching to reduce differential gain and differential phase) to ensure signal accuracy as well as long term stability and repeatability.

Since all signals are stored in replaceable EPROMs, changing needs and industry standards will not cause obsolescence.

Control and versatility of the 1910 are greatly enhanced by the use of its RS-232 control port. Most functions of the 1910 can be controlled, reconfigured and saved. This includes VITS and full field signal selection, matrix signal creation, sequences and other features.

Program Line

The 1910 offers full VITS and VIRS insertion capabilities which can be controlled through the RS-232 control port or through ground closures with the remote control unit. The 1910 may be used to insert either internally or externally generated test signals or data patterns in any combination on lines 10 through 21. Full sync and burst insertion capabilities with accurate SCH phasing eliminate the need for proc amps. When used as VITS inserter, the program line is bypassed upon loss of incoming sync to prevent nonsynchronous VITS or sync insertion. The 1910 may be reconfigured so that transmitter protection may be enabled where the loss of incoming sync will automatically cause a test signal to be inserted on the program line to maintain sync continuity until normal operation is restored.

External VITS Inputs

Four terminated inputs are standard in the 1910. Externally generated VITS from another source such as teletext, source ID, close captioning, etc. can be internally gated and inserted into the program. External VITS can be inserted on any field of lines 10 through 21 as selected by RS-232 control port or the remote control unit.

Pulse Out Feature

This included feature of the 1910 allows the user to change the four external VITS inputs to four pulse outputs for limited camera drive. The outputs available are H Drive, V Drive, Composite Blanking, and Burst Flag. Applications for pulse outputs are remote vans or standby sync generators. Composite sync and subcarrier outputs are always available.

The 1910 can also be used as a stand-alone signal source that will remain SCH phased and locked to an internal oven-controlled reference.

Remote Control

Remote control via a ground closure interface allows the user to control the full field signals, VITS insertion on lines 14 through 21 (VITS changes are saved in nonvolatile memory), VIR mode, bypass/operate, genlock source, control mode and reset to preprogrammed condition.

Programmability and RS-232 Control Port Features

The 1910 has a friendly command language that allows the user to program its features to meet specific applications. The user does not need to be a programming expert as the 1910 has a language that allows him to concentrate on the applications and not on programming.

The 1910 can be programmed and controlled using an RS-232 terminal. It can also be controlled or run under program control using an RS-232 host computer, including some handheld models or personal computers. The host computer could also be the Tektronix 1980 Automatic Measurement Set which would use the 1910 as a progammable signal source to stimulate and measure television equipment or a transmission link.

The 1910 can also be controlled over telephone lines. An auto-answer modem connected to the 1910 will allow the user to take control of the 1910, observe or modify its status and subsequently release control. The control and reconfiguration can also be accomplished automatically by a host computer.

Some of the capabilities offered by the RS-232 port include the ability to redefine the signal selection on the front panels (1910 and remote control unit) to better meet particular user needs, such as placing frequently used signals in a preferred position or in a convenient sequence for calibration; production testing or other special uses.

Nonvolatile Memory

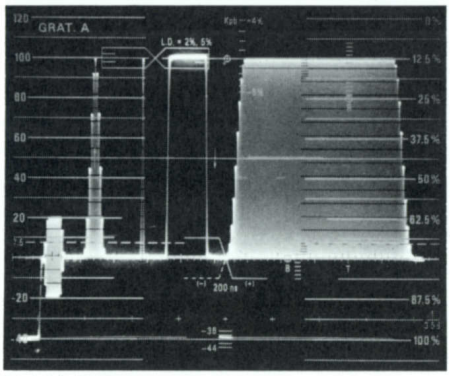
The 1910 has an EEPROM nonvolatile memory (no need for battery back up) where configurations different from the factory set can be saved even if the instrument is powered down or a power failure occurs (a nonvolatile memory retains the information stored in it even if the power has been turned off).

The Following Special Features Are Also Available Through the Control Port:

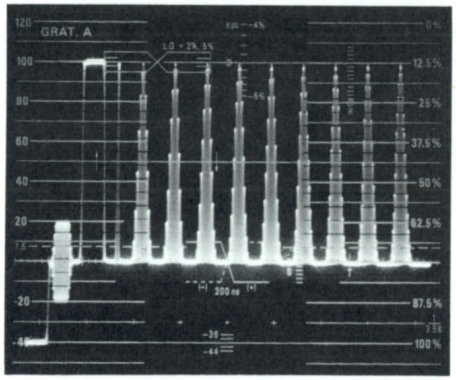
Signal Sequencing

The 1910 has commands that allow the user to program the VITS or full field signals to be displayed for definable periods of time in specific sequences.

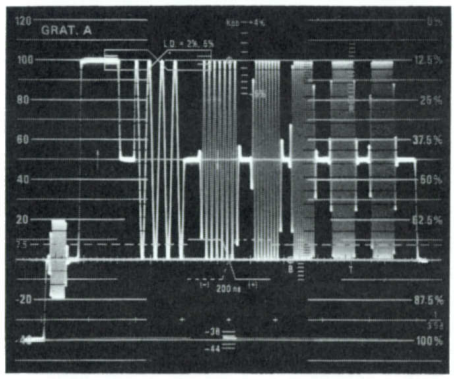
Signal Sequence Applications:
An example of color frame sequence would be to set field one to white and the other three fields to black. In this way it becomes simple to identify color field one for an accurate indication of SCH framing. This particular color frame sequence can also test the delay through frame synchronizers, effects generators, etc.



Modulated Bar



The Color Multipulse allows delay and amplitude measurements through chroma codecs.



Multiburst 100 IRE

The VITS sequence can optimize the use of the vertical interval by specifying different signals (e.g. test signals, teletext, etc.) for each of the four color fields. One line of the vertical interval can be used to insert up to four signals. These signals may be programmed to change to new signals with the time sequence feature, thus multiplexing many signals onto one vertical interval line.

Sequencing full field or VITS signals provides for manual or automated testing without requiring operator interaction. It also is useful in generating programmable duty-cycle signals.

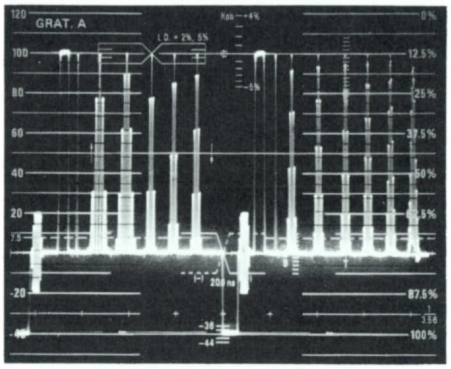
Digital Word Input and Output

The 1910 features a composite digital parallel data input and output. The digital data output provides a 10-bit digital word of the selected test signal. This highly accurate digital test signal may be used to evaluate and align D to A converters. It's a useful feature as the error incurred in digitizing an analog signal for this purpose is eliminated. The digital data is not modified to compensate for inadequacies in the analog reconstruction process.

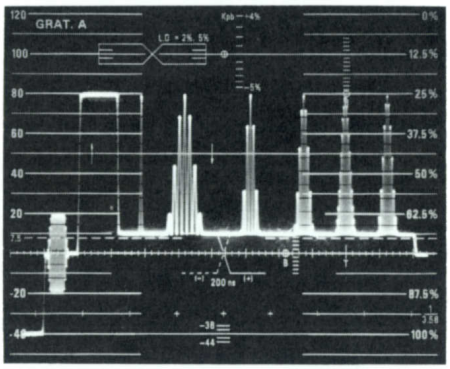
The digital data input will accept a user-generated digital word (up to 10 bits) for conversion to analog with the precision DAC in the 1910. The DAC, with its deglitching circuitry, will yield 10-bit accuracy, 0.6 percent differential gain and 0.3 degree differential phase performance.

Diagnostics

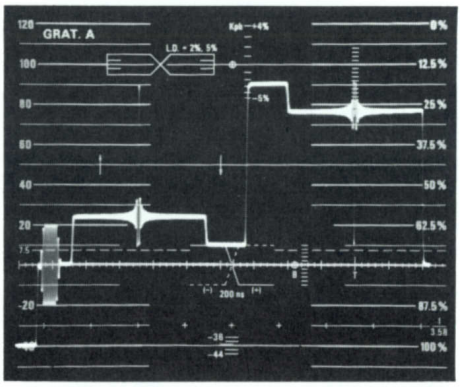
When powering up, the 1910 automatically performs a number of checks to determine if its microprocessor interface is working properly. More extensive internal diagnostics are available for further isolation of faults on an out of service basis.



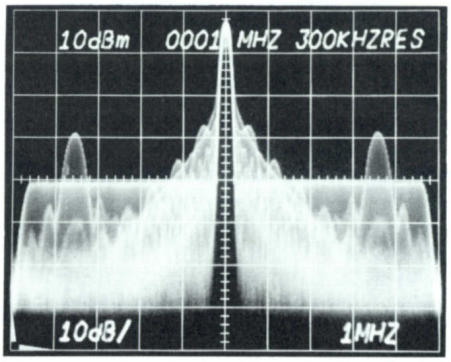
The Special Multipulse has pulses which extend to 6 MHz allowing delay and amplitude measures past the normal TV channel band edge.



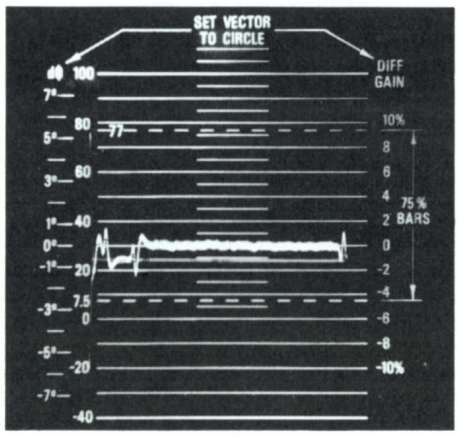
Multipulse 70 IRE



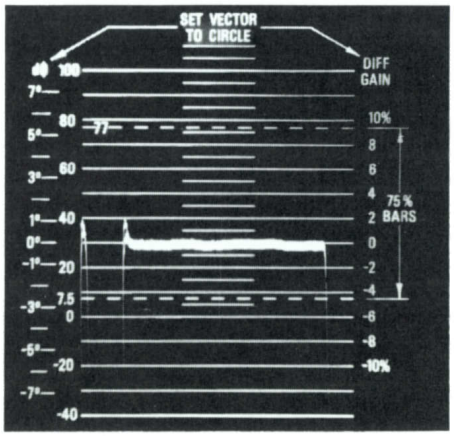
$\frac{Sin\ x}{x}$ *(Time Domain)*



$\frac{Sin\ x}{x}$ *(Frequency Domain)*



Modulated Ramp — Differential Phase

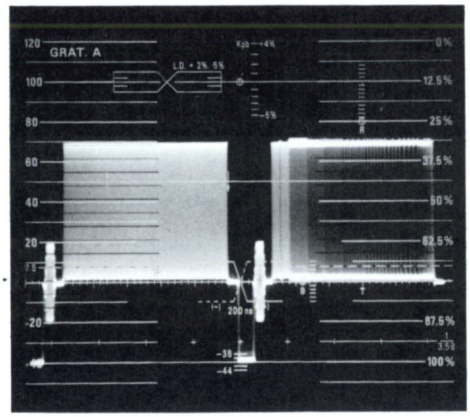


Modulated Ramp — Differential Gain

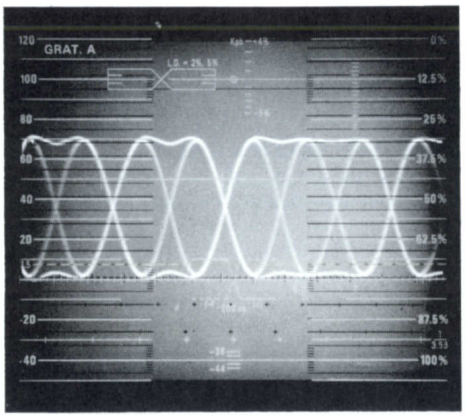
NEW

EYE HEIGHT DATA TEST SIGNAL

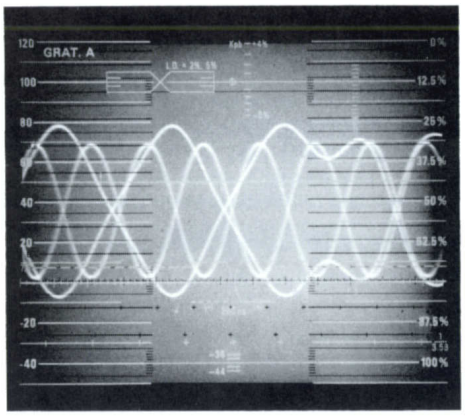
The eye test pattern signal indicates the capability of a system to pass teletext or similar data patterns. Programming the eye test pattern and the eye test reference signals into a VITS or a field sequence allows monitoring for the possibility of data errors. A standard waveform monitor can be used to observe the resulting zero crossings and data height relative to the clock reference.



Eye test data pattern



Data pattern and clock pattern overlaid with no distortion.



Same position in signal as last photo but through an uncompensated 4.2 MHz low pass filter. Note the time displacement and the amplitude error closing the data pulses' usable window area.

CHARACTERISTICS

PROGRAM CONTROL SYSTEM VITS INSERTER

Program Line Input Level — 1 V ±3 dB (0.7 V to 1.4 V) into 75 Ω.

PROGRAM LINE/MONITOR OUT

Impedance — 75 Ω nominal.

Hum Rejection — ≥10 dB (≥20 dB user selectable), referenced to 1 V hum.

Keyboard (No Noise) — <0.25 IRE.

Video Gain — Unity gain ±0.5%.

Inserted Pedestal Offset — 0 V hum: ≤2 mV. 1 V hum: ≤10 mV.

Pulse to Bar Ratio — T/2 Pulse to Bar Ratio: 100% ±2%. 1T Pulse to Bar Ratio: 100% ±0.5%. 2T Pulse to Bar Ratio: 100% ±0.25%.

Frequency Response — 0.5% to 5 MHz; 1.0% to 10 MHz; 3.0% to 15 MHz.

Differential Phase (10 to 90 APL) — ≤0.15°.

Differential Gain (10 to 90 APL) — ≤0.2%.

Random Noise (Weighted) — ≥75 dB (RMS) down, referenced to 1 V.

Spurious Signals During Blanking — Up to 5 MHz (Insertion Transient): ≥40 dB down (≤10 mV). Above 5 MHz (Clock Noise): ≥46 dB down (≤5 mV).

Delete Mode Signal Attenuation — 2T Pulse: ≥70 dB down, referenced to 0.714 V. Subcarrier: ≥60 dB down, referenced to 0.714 V.

Crosstalk (Internal to Program Line) — 2T: ≥70 dB down, referenced to 0.714 V. Subcarrier: ≥60 dB down, referenced to 0.714 V.

EXTERNAL VITS INPUT

Insertion Gain — Unity: ±1% (into 75 Ω).

Insertion Level — Dc Coupled: ±2 mV.

Frequency Response — Flat within 1% to 5 MHz.

Pulse to Bar Ratio — 2T: 100% ±1%. 1T: 100% ±2%.

External Input Isolation — >60 dB to 5 MHz.

Switching Transients — <10 mV p-p to 5 MHz.

GENLOCK

Source — Program Input or Black Burst Input.

Sync or Burst Amplitude — 40 IRE ±6 dB.

Burst Lockup Range — 3.579545 MHz ±20 Hz (sync must be locked to burst).

Sync Lockup Range — 15.73426 kHz ±0.079 Hz.

Free Run Frequency — 3.579545 MHz ±10 Hz. Temperature controlled, four times subcarrier oscillator normally locked to burst, or sync when burst absent.

Jitter — <5 ns (free run and burst lock mode).

FULL FIELD OUTPUT TIMING

All signal components (pulses, transitions and sinewaves) are digitally generated. The position of these components are repeatable between 1910s to better than 10 ns. The frequency accuracy of any sinewave depends on a master 14.31818 MHz oscillator. Timing of sync and burst is to EIA RS-170A specifications.

Line Blanking Width — 11.5 μs ±100 ns at 50% amplitude points (measured on 100 IRE Ped).

Front Porch Width — 1.8 μs ±100 ns at 50% amplitude points (measured on 100 IRE Ped).

FULL FIELD OUTPUT GENERAL

Output Impedance — 75 Ω nominal.

Dc Level — 0 V ±2 mV (Clamp On); 0 V ±50 mV (Clamp Off).

Luminance Gain — Within ±1%. All luminance levels are digitally defined and will be within ±0.5 LSB (±1.3 mV or ±0.2 IRE) of the correct value relative to the calibrated 100 IRE level.

Chroma Amplitude Accuracy — Within ±0.72% (adjustment accuracy) plus quantizing error.
Definition of Quantizing error = $\frac{40 \text{ IRE} \times 0.6\%}{\text{chroma amplitude}}$

Relative Frequency Flatness — ±0.3% typical from 56 kHz to 5 MHz with 0.714 mV p-p (digital sweep generator and p-p detector). ±1% maximum using 50 IRE Multiburst (500 kHz to 4.2 MHz).

Differential Phase — ≤0.3° using 100 IRE Mod Ramp with 40 IRE p-p subcarrier.

Differential Gain — ≤0.6% using 100 IRE Mod Ramp with 40 IRE p-p subcarrier.

2T Pulse to Bar Ratio — 100% ±1%.

2T Pulse Ringing — ≤1 IRE p-p.

Group Delay Error — ≤10 ns, up to 5.0 MHz.

FULL FIELD AND VITS SIGNALS TEST SIGNAL SPECIFICATIONS

FCC Multiburst and Multiburst 100 IRE — Frequencies: 0.5, 1.3, 2.0, 3.0, 3.58 and 4.1 MHz.

NTC 7 Combination — Frequencies: 0.5, 1.0, 2.0, 3.0, 3.58 and 4.2 MHz. Chroma: 20, 40, 80 IRE at 90°.

Multipulse 100 IRE — Frequencies: Same as NTC 7 Combination without 0.5 MHz.

Multipulse 70 IRE — All pulses on a 10 IRE pedestal. Frequencies: Same as FCC Multiburst without 0.5 MHz.

Color Multipulse — Subcarrier frequency for center pulse. Pulses to the left are decreasing in frequency by 300 kHz increments while pulses to the right are increasing in frequency by 300 kHz.

Special Multipulse — Frequencies: 1 MHz through 6 MHz at 500 kHz increments.
Note: This signal uses two adjacent lines.
$\frac{\text{Sin } x}{x}$
Spectrum: −3 dB at 4.75 MHz. Positive and negative pulses.

FCC Composite — 80 IRE staircase.

NTC 7 Composite — 90 IRE staircase.

Ramp (100, 80) — Luminance: 100/80 IRE.
Chroma: 40 IRE at 180°.

Staircase (5 Step, 10 Step) — Luminance: 100 IRE.
Chroma: 40 IRE at 180°.

Inverted Pulse and Bar — Positive and negative 2T pulses.

Modulated Bar — Chroma: 100 IRE at 33°.

Modulated Pedestal — Chroma: 20, 40, 80 IRE at 90°.

Color Bars, Y Bars — 75% amplitude, 7.5% setup, 6.5 μs/bar (8 bars).

Red Field — 75% amplitude, 7.5% setup.

Bars/Y — Split field of Color Bars followed by Y Bars.

Bars/Red — Split field of Color Bars followed by Red Field.

EIA Bar — 75% amplitude, 7.5 setup, 7.5 μs/bar (7 bars). SMPTE compatible.

IYQB (with PLUGE) — SMPTE compatible.

Reverse Blue Bars — Blue component of EIA Bar. SMPTE compatible.

SMPTE Bars — Split field of EIA Bar, Reverse Blue Bars, and IYQB.

VIRS — Luminance: 70, 50, 7.5 IRE. Chroma: 40 IRE at 180°.

VICR*1 — Luminance: 50, 100, 7.5 IRE. Chroma: 100 IRE at 180°.

Convergence — 14 x 17 crosshatch with dots.

APL, Bounce, Black Burst (7.5), 10, 25, 50 and 100 IRE Ped — Full line width.

Field Bar — 100 IRE. 18 μs wide.

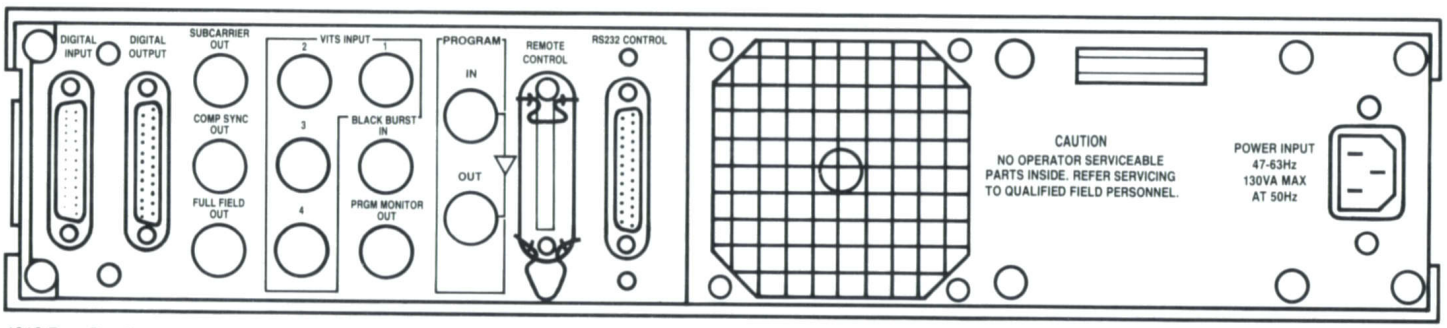
Field Squarewave — Same as 100 IRE Pedestal.

Window — Same as Field Bar.

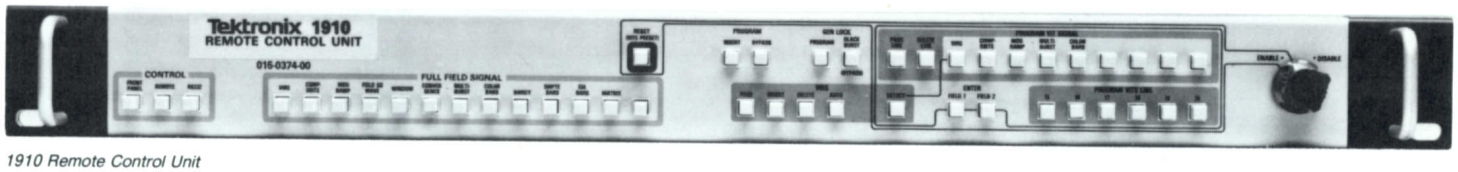
Eye Test Pattern — Test pattern at 5.7 Mbit/s. Risetime: 100 ns.

Eye Test Reference — Alternate "1", "0" pattern at 5.7 Mbit/s. Risetime: 100 ns.

Matrix (Factory Set, but User Redefinable) — Matrix 1: Mod 10 Step, Color Bars, Red Field. Matrix 2: Mod Ramp 100 IRE, EIA Bar, Reverse Blue Bar, Multipulse 100 IRE. Matrix 3: Convergence, EIA Bars, Reverse Blue Bar, Convergence, IYQB, Convergence.



1910 Rear Panel



1910 Remote Control Unit

SYNC AND SUBCARRIER OUTPUT

All pulse outputs have negative going output levels of 4 V ±10% into 75 Ω and have a rise and falltime of 140 ns ±20 ns.
Composite Sync Timing — EIA RS-170A Specifications.
Subcarrier Output — Frequency: See Genlock. Amplitude: 2 V p-p ±10%.
The following optional outputs replace the external VITS input function of the 1910.
Composite Blanking — Horizontal Blanking Width: 10.7 μs ±100 ns. Field Blanking: Field 1=21 lines, Field 2=21 lines.
Horizontal Drive Timing — Start of line blanking to end of line sync, ±100 ns.
Vertical Drive Timing — Coincident with start of field. Duration: 9 lines.
Burst Flag — Duration: 2.5 μs ±100 ns. Delay from Line Sync: 5.3 μs ±100 ns.

RS-232C INTERFACE

Supports EIA Standard RS-232C format to the extent shown below.
Baud — 300, 1200, 2400 or 4800 bits/s.
Input/Output — ASCII, serial, asynchronous data. Full duplex input and output.
Character Length — Eleven bits/character, including a start and 2 stop bits.
Parity — Input: No parity required and, if present, is ignored. Output: No parity sent.

DIGITAL DATA INTERFACE

Parallel, 12 balanced, signal pairs consisting of 10 bits/sample, a clock, a timing reference signal.
Sampling Frequency — Four times color subcarrier. Nominally 14.3 MHz.
Sampling Phase Angle — Referenced to I and Q axis.
Dynamic Range — 10 bits/sample: Blanking level (0 IRE) is at digital word 240. Reference white (100 IRE) is at digital word 800 (5.6 LSB/IRE).
Input Logic Levels Terminated in 100 Ω — 10 k ECL compatible.
Output Logic Levels — 10 k ECL compatible.
Digital Input Timing — Setup and hold times are 10 ns before and after the 50% point of the negative transition of the clock.
Output Clock Timing — The 50% point of the leading edge of the clock pulse preceeds the data by 5 ns ±5 ns.

POWER SUPPLY

Line Voltage Range — 90 V ac to 132 V ac. 180 V ac to 250 V ac.
Maximum Power Consumption — 130 W.
Line Frequency — 47 Hz to 63 Hz.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	442	17.4	486	19.1
Height	96	3.8	88	3.5
Depth	525	20.6	525	20.6
Weight	**kg**	**lb**	**kg**	**lb**
Net	11.6	25.5	12.2	27.0
Shipping	16.7	37.0	16.7	37.0

ENVIRONMENTAL CHARACTERISTICS

Temperature — Operating: 0°C to +50°C. Nonoperating: −40°C to +65°C.
Altitude — Operating: To 4572 m (15,000 ft). Nonoperating: To 15 240 m (50,000 ft).
**1 Vertical interval color reference*

INCLUDED ACCESSORIES

Pair of rack slides (351-0636-00); pulse out board (670-8007-00); cabinet hardware; rack hardware; operator manual; service manual.

ORDERING INFORMATION

1910 Digital Generator **$9,900**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro, 220 V/16 A, 50 Hz
Option A2 — UK, 240 V/13 A, 50 Hz
Option A3 — Australian, 240 V/10 A, 50 Hz
Option A4 — North American, 240 V/15 A, 60 Hz

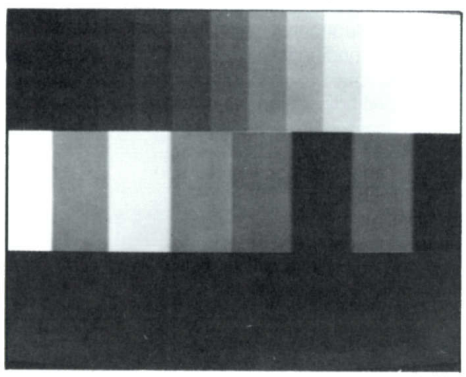
OPTIONAL ACCESSORIES

Remote Control Unit Order 015-0374-00 ..... **$300**
6 ft Interconnecting Cable Order 012-0108-00 ..... **$150**
22 ft Interconnecting Cable Order 012-0251-00 ..... **$285**

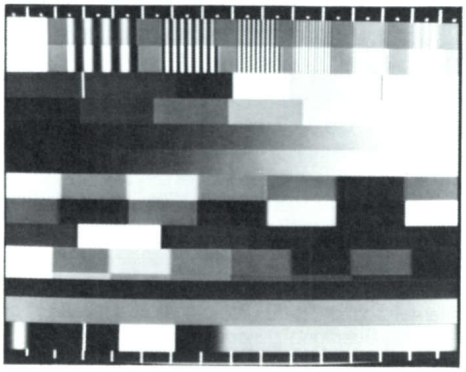
SIGNAL MATRIXING

The matrix feature of the 1910 divides the field into 16 blocks of lines consisting of approximately 16 lines each. Through the RS-232 control port the user can program any full field signal to appear in any of the 16-line blocks. Any signal can be repeated in as many blocks as necessary. There are three matrix signals in the 1910 that are factory set, but can be user-redefined and saved in a nonvolatile memory.

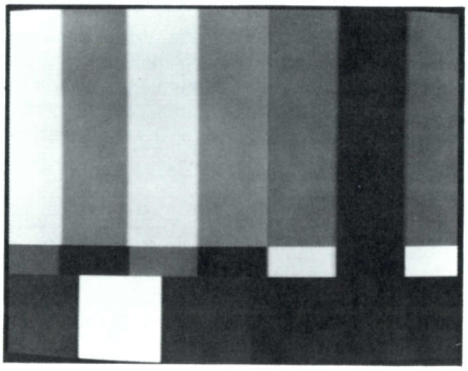
Some of the applications of this feature include user-defined tape headers or monitor test patterns. The matrixed signal can serve several users simultaneously, reducing the need for multiple signal outputs. By using the 15-line feature of the Tektronix 1480-Series Waveform Monitors, particular signals in the matrix can be viewed by the users.



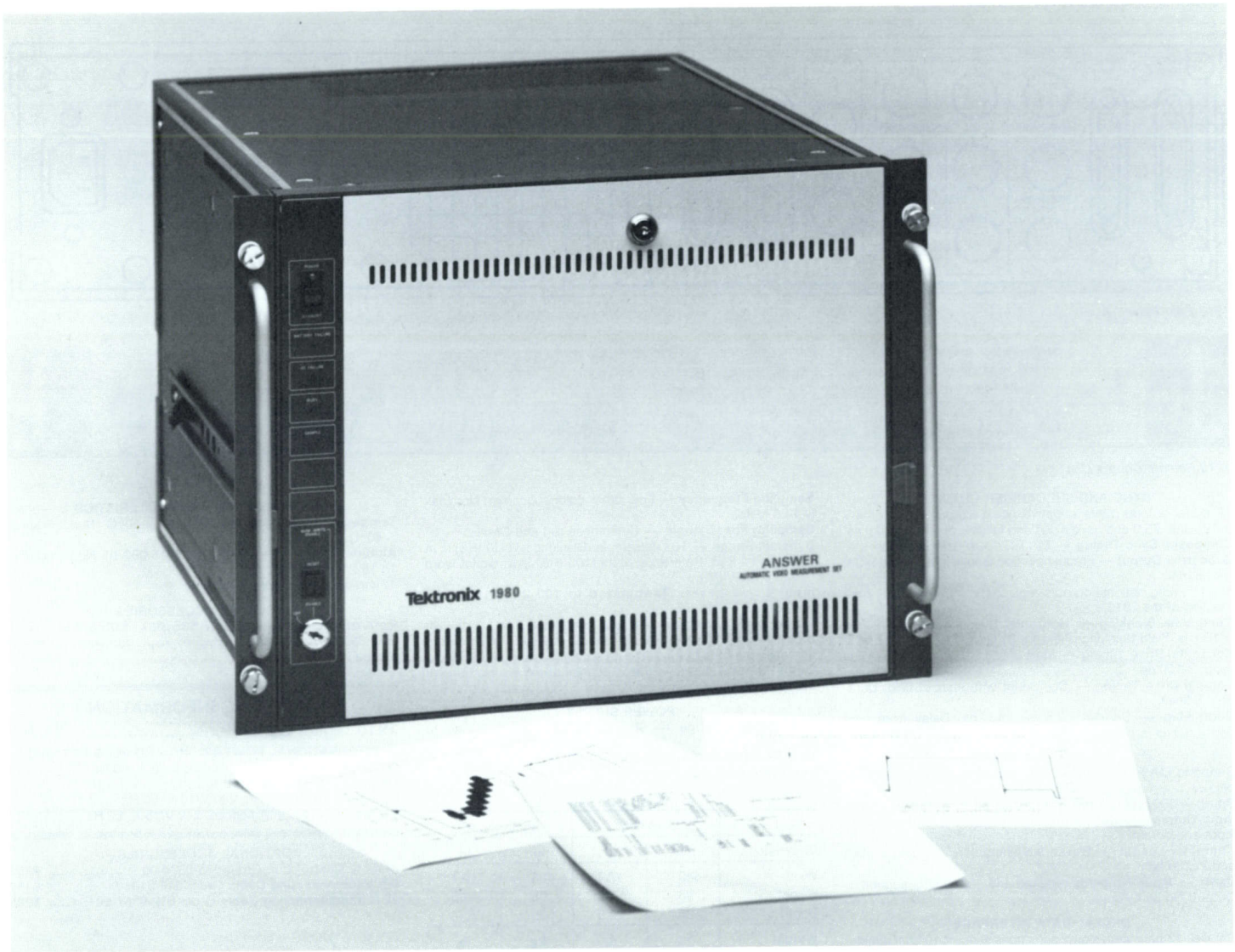
Matrix composed of modulated stairstep, full field bars and red field.



An arbitrary test pattern showing all 16 blocks of the signal matrix capability, used by as many test signals.



SMPTE color bars test signal made up using the 1910 signal matrixing feature. (SMPTE bars are also available on the front panel as a standard signal).



1980 ANSWER

Complete Video Measurement Capability

Waveform Digitizer to Capture Video Signal

ANSWER BASIC Software for Measurements, Analysis and Report Generation

Remote Terminal Capability

The 1980 ANSWER Automatic Video Measurement Set provides total video measurement capabilities and offers maximum versatility and testing power. Special features provide quality measurement performance for a wide variety of applications.

Programmability

The 1980 can be programmed using ANSWER BASIC (BASIC software, Options 01, 04, 05 or 06) to make specific measurements required for a wide range of video applications. It can be tailored for a specific operation, automatically performing a single measurement or a group of measurements continuously, on operator demand, or at prescheduled times. The results can be returned in report format, with or without graphics, on a variety of terminals and printers. ANSWER's microprocessor control and ROM memory give you extensive flexibility. Format or standard changes can be made without the expensive modifications or recalibrations associated with analog test equipment.

High Measurement Accuracy

The 1980 provides consistent measurement accuracy with high repeatability. Special features like signal offset, gain control, dither generation, and signal averaging can be used to minimize possible errors. Using these features can significantly reduce noise on the incoming signal and provide an effective resolution of 11 bits. This means you can use the 1980 for the most stringent measurement problems and have fast accurate results.

Due to its digital nature ANSWER has very few internal adjustments, providing a high degree of reliability over long periods of time.

Amplitude, Phase and Timing Measurement

All type of measurements can be programmed into the 1980, including sync, burst, and bar amplitudes, differential gain and phase, and timing measurements. The 1980 can tell you immediately if video signals are within acceptable or legal limits.

Remote Operation

The 1980 can also be operated from a remote terminal over telephone lines. With Option 12 (Autocall), it can even be programmed to automatically telephone a remote terminal under user specified conditions, e.g., an out-of-limits signal. The 1980 can be used in a wide range of applications including unattended and remote transmission systems, and systems under computer control.

Display Terminal

ANSWER requires the use of a terminal for display. We offer several including the 4006-1 11 inch CRT Graphics Terminal, the 4014-1 19 inch CRT Graphics Terminal, and the 4025A 12 inch Raster Scan CRT Terminal, also with graphics. We also offer the 4631 Hard Copy Unit for clean, dry, hard copies.

Available Measurement Programs

Application programs taking full advantage of the 1980's capabilities can be purchased from Tektronix to make most NTSC and PAL video broadcast measurements.

This flexibility, unavailable in analog instruments, combined with the video measurement capability means that the 1980 can be tailored to a wide range of your applications for the analysis, measurement, and testing of baseband video signals.

RS-232C Compatibility

ANSWER has RS-232C (ASCII coding) interface capability. This means ANSWER can be adapted to a wide range of applications, including unattended and remote systems and computer control.

CHARACTERISTICS

SIGNAL HANDLING

Inputs — A and B (user selectable).

Impedance — 75 Ω.

Return Loss — Video: ⩾46 dB to 5 MHz.

Signal Level — 0.5 V to 2 V p-p; sync negative.

Coupling — Dc or ac nonfloating (user selectable).

Clamp — Selection: Fast, slow, or off (user selectable). Level: Sync tip or back porch.

Hum Rejection — Fast: >36 dB. Slow: <1 dB.

Signal Averaging — Noise Reduction: 15 dB; with 32 line averaging and incoming signal-to-noise ratio of 46 dB or less. Dynamic Range: 2.5 V maximum; with 0 offset. Gain Range: 0 to 15.5 times in 0.5 increments. Offset Range: 0 to 248 LSB ±0.5 LSB (8 LSB increments); referred to input at unity gain. Noise Floor: −72 dB (0 dB = 714 mV).

Distortions — Differential Gain Error: ⩽0.5%. Differential Phase Error: ⩽0.4°. Luminance Nonlinearity Error: ⩽1.0%. Amplitude/Frequency Error (0 MHz to 5 MHz): 0 dB ±0.25 dB; 7.16 MHz = ⩾−46 dB. Delay/Frequency Error (0 MHz to 5 MHz): ⩽20 ns.

SYNCHRONIZATION

Modes — Internal: Satisfactory operation with 26 dB signal-to-noise ratio (Sound-in-Syncs disabled). Channel A and B (user selectable). External: Channel A and B (user selectable).

Amplitudes — Internal Mode: 143 mV (20 IRE) minimum; negative going sync on incoming signal. External Mode: Minimum: 0.2 V p-p into 75 Ω, composite sync. Maximum: 8.0 V p-p into 75 Ω, composite sync.

ANALOG TO DIGITAL CONVERSION

Resolution — 8 bits; 11 bits effective with dither.

Accuracy — RMS: ±0.25 LSB (±0.1%). Peak: ±0.5 LSB (±0.2%).

Conversion Rate — 20 MHz maximum.

Monotonicity — All 256 codes present and in sequence with no polarity reversals.

Sampling Rate — NTSC: 910 x horizontal frequency. PAL: 1135 x horizontal frequency.

Note: User selectable means that the function is controlled from the keyboard.

DIGITAL PROCESSING

Signal Memory — Video Acquisition Memory Capacity: 32 k samples. Video Acquisition Memory Controller Sampling Modes: Line rate, field rate or block sampling between two points on signal. Save Value: Multiples of eight. Skip Value: Multiples of two. Picture Monitor Bright-Up Pulse Output: Amplitude: ≈240 mV. Termination: Internal in 75 Ω.

Real Time Clock — Internal Reference Stability: 10 P/M total over +10°C to +50°C; crystal controlled. External Input Frequency: 1 MHz. External Input Amplitude: 0.3 V to 4.0 V.

Microcomputer — User Memory: 32 k words. Nonvolatile Memory: 8 k words.

Software Control — TEK ANSWER BASIC.

DIGITAL INTERFACE

Access Ports — Interface: RS-232C; (ASCII code). Number: 5; 3 DCE*1 (full duplex). 2 DTE*2 (full duplex).

Baud Rate — Five Ports: Up to 9600; user programmable.

Automatic Call-Up — RS-366 (optional).

User Operation — Via keyboard (ASCII).

1 DCE = Data Communication Equipment
2 DTE = Data Terminal Equipment

ENVIRONMENTAL CHARACTERISTICS

Temperature Range — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude Range — Operating: Sea level to 4572 m (15,000 ft). Nonoperating: Sea level to 15 240 m (50,000 ft).

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	429	16.9	483	19.0
Height	355	14.0	355	14.0
Depth	593	24.0	644	22.0
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	25.0	55.0		

INCLUDED ACCESSORIES

Left rackmounting adaptor (367-0279-00); right rackmounting adaptor (367-0280-00); tracks (351-0104-03); 15 ft RS-232C modem connecting cable (012-0939-00); rubber cabinet feet (348-0068-00); power cord (161-0066-01); rack slides (351-0623-00); manual.

1980 ANSWER Option 01 Applications Software

Unattended Monitoring of NTSC Video Signals

Most RS-170A, NTC-7, and FCC Measurements

Waveform Plots For Analysis and Documentation

Remote Operation

Automatic Logging

User Definable Measurement Limits

Operator-Initiated Individual Measurements

NTC-7 Out-Of-Service Measurements

Vertical Interval Autoscan for Automatic Test Signal Locations

Video Switch for Multisource Capability

With the Option 01 NTSC Applications Software, ANSWER makes automatic or operator-initiated measurements on VITS and full field signals. Amplitude, phase, and timing parameters can all be determined quickly and accurately.

Unattended Monitoring

The 1980 ANSWER Option 01 can continuously monitor video signals, make standard measurements, compare them against user-defined limits, and print alarm messages should these limits be exceeded.

RS-170A, NTC-7, and FCC Measurements

Option 01 will make RS-170A and FCC timing measurements, as well as amplitude and phase measurements on both NTC-7 and FCC VITS.

Waveform Plots

Waveforms can be plotted on local or remote graphics devices for further analysis. Any portion of the waveform can be expanded to fill the screen and examine small distortions in detail. Hard copies of the waveform plots are useful for support documentation and trend analysis.

Remote Operation

The Option 01 Program can be operated from a remote terminal over voice-grade telephone lines. With Option 12 (Auto-Call) it will automatically dial up a remote terminal under user specified conditions e.g. an out-of-limits signal.

Automatic Logging

A user-defined set of measurements will automatically be made and the results printed at operator-scheduled times.

User-Definable Measurement Limits

The user can specify inner (caution) and outer (alarm) limits for each measurement parameter, and different sets of limits for the two 1980 video input channels.

Operator-Initiated Individual Measurements

Monitoring can be interrupted at any time to make one or more individual measurements, once or repeatedly. The numeric results are printed. Combined with the capability to plot waveforms, this makes ANSWER a powerful troubleshooting instrument.

NTC-7 Out-Of-Service Measurements

Field time distortion, long time distortion and dynamic gain distortion are all made as specified in NTC Report 7.

Vertical Interval Auto-Scan

Standard test signals within the vertical interval are automatically located and the appropriate locations used during sampling.

Video Switch

Several video sources can be specified and the program will make complete sets of measurements sequentially on each of them. With an RS-232 controllable switcher and insertion of a few extra lines of code, the system will automatically switch in the correct video source.

CHARACTERISTICS, OPTION 01

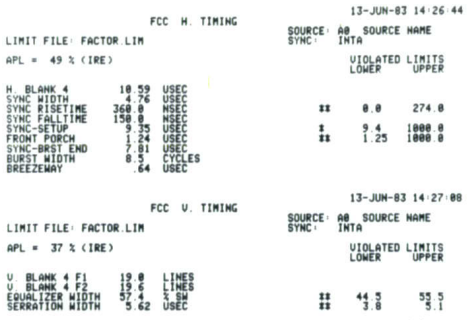
The measurement specifications cited in this section are valid only within the following environmental limits: Temperature range to 0°C to 50°C, with a minimum warm-up time of 20 minutes.

The following listing gives each measurement and its associated range and accuracy.

All measurement accuracies specified are valid over the entire dynamic range, with an unweighted signal-to-noise ratio of at least 46 dB on the incoming signal.

AMPLITUDE AND PHASE MEASUREMENTS

Measurement	Range	Accuracy
Bar Amplitude	30 IRE to 130 IRE units	±0.5 IRE
Sync Amplitude	20 IRE to 80 IRE units	±0.5 IRE
Burst Amplitude	10 IRE to 90 IRE units	±0.5 IRE
Average Picture Level	−20% +120% of 100 IRE	±3%
Reference Black Level	−20 IRE to 130 IRE units	±0.5 IRE
Line Time Distortion	0% to 40%	±0.5%
Pulse to Bar Ratio	10% to125%	±0.5%
2T Step Ringing	0% to 25%	±2%
Relative Chroma Gain	25% to 175%	±0.5%
Relative Chroma Time	±300 ns	±10 ns
Amplitude/ Frequency	0 IRE to 120 IRE	±1 IRE or ±2% whichever is greater
Luminance Nonlinearity	0% to 50%	±0.5%
Chrominance Nonlinear Gain	20 IRE Chroma 5 IRE to 35 IRE 80 IRE Chroma 45 IRE to 160/	±0.5 IRE
Chrominance Nonlinear Phase	0° to 180°	±1°
Differential Gain	0% to 180%	±0.4%
Differential Phase	0% to 100%	±0.5%
Chrominance Luminance Intermodulation	0 IRE to 50 IRE	±0.5 IRE
Signal to Noise Ratio	26 dB to 72 dB	within 1 dB
Low Frequency Periodic Noise	0 dB to 60 dB	within 1 dB
Relative Burst Gain	±50%	±0.5%
Relative Burst Phase	±180°	±0.4°



Measurement results are displayed in an easy-to-read format indicating the time, signal source, measurement and whether the measured value exceeded caution (*) or alarm (**) limits.

OUT-OF-SERVICE MEASUREMENTS

Measurement	Range	Accuracy
Field Time Distortion	0% to 40%	±0.5%
Long Time Distortion	Overshoot Range: 20 IRE to 100 IRE 0 IRE to 20 IRE Settling Time: 0.1 s to 30 s	±1.0 IRE ±0.5 IRE ±2% of bounce rate
Dynamic Gain Distortion	Picture Gain: ±25% Sync Gain ±25%	±1.0 IRE ±1.0 IRE

WITH ZERO-CARRIER PULSE PRESENT

Measurement	Range	Accuracy
Blanking Level	65% to 85% of max carrier	±0.5%
Reference White Level	2.5% to 22.5% of max carrier	±0.5%

FCC AND RS-170A TIMING MEASUREMENTS

Measurement	Range	Accuracy
H Sync Width	1 μs to 8 μs	±25 ns
Front Porch Duration	0.5 μs to 2 μs	±25 ns
Sync to Start of Video Duration	8 μs to 15 μs	±25 ns
Sync to Burst Start Duration	4 to 30 cycles	±20°
Sync to End of Burst Duration	6 μs to 15 μs	±20 ns ±0.05 burst cycle
H Blanking Width	8 μs to 30 μs	±50 ns
Color Burst Width	6 to 13 cycles	±1 cycle amplitude detection ±0.5 IRE
Breezway Width	−2.0 μs to 3.5 μs	±25 ns ±0.5 burst cycle
H Sync Rise and Falltimes	0.14 μs to 0.3 μs 0.31 μs to 1.0 μs	±20 ns ±30 ns
Equalizing Pulse Width	1 μs to 20 μs	±25 ns
Serration Width	1 μs to 20 μs	±25 ns
Vertical Blanking Width	20 to 50 lines	±140 ns

The Option 01 program is stored in PROMS on two circuit boards which plug into the 1980 base unit.

1980 ANSWER Option 04
NTSC Monitoring Software

Unattended Monitoring of NTSC Video Signals from Studios, STLs, Earth Stations, and Transmitters

Full Spectrum of RS-170A, NTC-7, and FCC Measurements

Waveform Plots For Analysis and Documentation

Remote Operation

Automatic Logging

User Definable Measurement Limits

Operator-Initiated Individual Measurements

VIRS Measurements

Vertical Interval Scan for Test Signal Locations

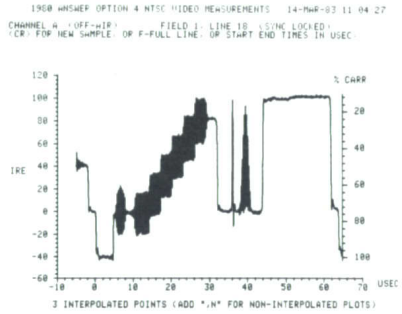
User-Defined Measurement Groups

With the Option 04 NTSC Video Signal Monitoring Software, ANSWER makes automatic or operator-initiated measurements on VITS and full field signals. Amplitude, phase, and timing parameters can all be determined quickly and accurately.

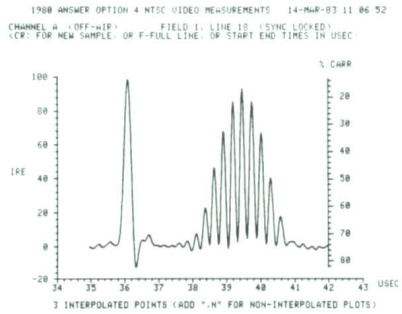
Unattended Monitoring
The 1980 ANSWER Option 04 can continuously monitor video signals, make user-selected standard measurements, compare them against user-defined limits, and print alarm messages should these limits be exceeded.

RS-170A, NTC-7, and FCC Measurements
Option 04 will make RS-170A and FCC timing measurements, as well as amplitude and phase measurements on both NTC-7 and FCC VITS. Amplitude measurements are reported as % of carrier, % of bar, or IRE units. This broad spectrum of measurement capability makes the Option 04 useful in many different video environments: at transmitters, in studios, at cable head-ends, at satellite earth stations and with TV equipment manufacturers.

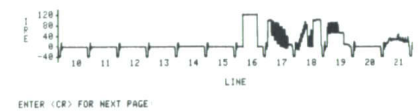
Waveform Plots
Waveforms can be plotted on local or remote graphics devices for further analysis. Any portion of the waveform can be expanded to fill the screen and examine small distortions in detail. Hard copies of the waveform plots are useful for support documentation and trend analysis.



Any line of video can be graphed on graphic display terminals and hard-copy devices locally, or at remote locations.



Any portion of a line can be expanded for detailed analysis.



Waveform on lines 10 through 21 can be graphed for quick visual recognition of vertical interval line usage.

Remote Operation
The Option 04 Program can be operated from a remote terminal over voice-grade telephone lines. With Option 12 (Auto-Call). It will automatically dial up a remote terminal under user specified conditions e.g., an out-of-limits signal.

Automatic Logging
A user-defined set of measurements will automatically be made and the results printed at operator scheduled times.

User-Definable Measurement Limits
The user can specify inner (caution) and outer (alarm) limits for each measurement parameter, and different sets of limits for the two 1980 video input channels.

Operator-Initiated Individual Measurements
Monitoring can be interrupted at any time to make one or more individual measurements, once or repeatedly. The numeric results are printed. Combined with the capability to plot waveforms, this makes ANSWER a powerful troubleshooting instrument.

VIRS Measurements
The system will measure reference black (setup) level and chrominance phase relative to burst. These measurement results are especially sensitive indicators of the perceived quality of the signal of the "end-viewer" at a home receiver, which is the "bottom line" of video signal quality control.

Scan the Vertical Interval for Test Signal Locations
NTC-7 or FCC VITS and VIRS can be located by using the Option 04 Program to scan the vertical interval and "memorize" the field and line locations of these well-defined waveforms. The locations found are used in subsequent sampling. Also, the waveforms on lines 10 through 21 can be plotted, enabling the operator to visually locate the zero carrier pulse, digital data, or a quiet line.

User-Specified Measurement Groups
New commands can be created each of which "stands for" a sequence of Option 04 commands. This enables unique Option 04 command sequences to be developed which perform a measurement task that is tailor-made for the user's application. Thereafter, only the user-coined command name needs to be typed to initiate the series of measurements.

NEW

CHARACTERISTICS, OPTION 04

The measurement specifications cited in this section are valid only within the following environmental limits: Temperature range of 0°C to 50°C with a minimum warm-up time of 20 minutes.

The listing below gives each measurement and its associated range and accuracy.

All measurement accuracies specified are valid over the entire dynamic range, with an unweighted signal-to-noise ratio of at least 46 dB on the incoming signal.

HORIZONTAL INTERVAL TIMING MEASUREMENTS

Measurement	Range	Accuracy
Breezeway Width	0.2 μs to 3.5 μs	±25 ns
Color Burst Width	6 to 13 cycles	±0.1 cycle
Front Porch Duration	0.5 μs to 2 μs	±25 ns
Horizontal Blanking Width	6 μs to 30 μs	±50 ns
Horizontal Sync Risetime and Falltime	80 μs to 1 μs	±30 ns
Horizontal Sync Width	1 μs to 8 μs	±25 ns
SCH Phase	±90 °	±5 °
Sync to Setup	5 μs to 18 μs	±25 ns
Sync to Start-of-Burst	4 μs to 8 μs (i.e. 16 to 30 cycles)	±140 ns (0.5 cycles) ±20 ns
Sync to End of-Burst	6 μs to 15 μs	±20 ns

VERTICAL INTERVAL TIMING MEASUREMENTS

Measurement	Range	Accuracy
Equalizing Pulse Width	25% to 200% of nominal horizontal sync pulse width	±0.5%
Serration Width	1 μs to 20 μs	±25 ns
Vertical Blanking Width	19 to 29 lines	−0.1 lines to +0.2 lines

FCC COLOR BAR MEASUREMENTS

Measurement	Range	Accuracy
Color Bar Amplitude Errors	±100% of nominal	±1.0% or ±1.0 IRE, whichever is greater
Color Bar Phase Errors	±180° from nominal	±1°
Color Bar Chrominance-Luminance Gain Ratio	0% to 200% of nominal	±2%

AMPLITUDE AND PHASE MEASUREMENTS

Measurement	Range	Accuracy
Bar Amplitude Zero Carrier Pulse Present	0% to 90% of Carrier	±0.4%
Zero Carrier Not Present	0 IRE to 200 IRE	±0.5 IRE
Chrominance-Luminance Delay	±300 ns	±20 ns
Chrominance-Luminance Gain	0% to 160%	±1%
Differential Gain	0% to 100%	±0.5%
Differential Phase	0° to 360°	±0.4°
Luminance Non linear Distortion	0% to 50%	±1%
Relative Burst Gain	±100%	±0.5%
Relative Burst Phase	±180°	±0.4°
Burst Amplitude % of Sync	25% to 200% of sync	±1.3% of sync or ±0.5 IRE, whichever is greater
% of Bar	10% to 80% of Bar	±0.5%
Bar Not Present	10 IRE to 80 IRE	±0.5 IRE
Sync Amplitude	20% to 80% of Bar	±0.5%
Bar Not Present	20 IRE to 80 IRE	±0.5 IRE
Blanking Level	0% to 90% of Max Carrier	±0.5%
Sync Variation	0% to 50% of Max Carrier	±0.5%
Zero Carrier Not Present	0% to 50% of Bar	±0.5%
Zero Carrier & Bar not present	0 IRE to 50 IRE	±0.5 IRE
Blanking Variation	0% to 50% of Max Carrier	±0.5%
Zero Carrier Not Present	0% to 50% of Bar	±0.5%
Zero Carrier & Bar not present	0 IRE to 50 IRE	±0.5 IRE
Vertical Interval White Level	0% to 90% of Max Carrier	±1.0%
Zero Carrier Not Present	0% to 100% of Bar	±1.0%
Zero Carrier & Bar not present	0 IRE to 100 IRE	±1.0 IRE
Maximum Picture White	0% to 90% of Max Carrier	±1.0%
Zero Carrier of Bar Not Present	0% to 100%	±1.0%
Zero Carrier & Bar Not Present	0 IRE to 100 IRE	±1.0 IRE
Minimum Picture Black	−40% to +100% of Bar	±1.0%
Bar Not Present	−40 IRE to +100 IRE	±1.0 IRE

FREQUENCY RESPONSE MEASUREMENTS

Measurement	Range	Accuracy
Multiburst Flag Amplitude	0% to 90% of max Carrier	±0.5%
Zero Carrier Not Present	20% to 130% of Bar	±0.5%
Zero Carrier & Bar Not Present	20 IRE to 130 IRE	±0.5 IRE
Multiburst Packet Amplitudes (6 Results)	0% to 100% of Flag	±3%

LINEAR WAVEFORM DISTORTION MEASUREMENTS

Measurement	Range	Accuracy
Line Time Distortion	0% to 40% of Bar	±0.5%
Pulse-to-Bar Ratio	10% to 125%	±1%
Short-Time Waveform Distortion	0% to 25%	±1%
Chrominance Nonlinear Gain Distortion	5 IRE to 35 IRE: 20 IRE chroma 45 IRE to 160 IRE: 80 IRE chroma	±0.5 IRE
Chrominance Nonlinear Phase Distortion	0° to 360°	±1.0°
Chrominance to Luminance Intermodulation	±50 IRE	±0.5 IRE

VIRS MEASUREMENTS

Measurement	Range	Accuracy
VIRS Setup Reference Black	−20% to 130% of Bar	±0.5%
Bar Not Present	−20 IRE to 130 IRE	±0.5 IRE
VIRS Chrominance Reference Amplitude	0% to 200% of burst amplitude	±1.0%
Burst Not Present	0% to 80% of Bar	±1.0%
Burst & Bar Not Present	0 IRE to 80 IRE	±1.0 IRE
VIRS Chrominance Phase Relative to Burst	±180°	±1.0°
VIRS Luminance Reference	30% to 100% of Bar	±1.0%
Bar Not Present	30 IRE to 100 IRE	±1.0 IRE

LOW FREQUENCY NOISE MEASUREMENT

Measurement	Range	Accuracy
Low Frequency SNR	26 dB to 60 dB	±1.0 dB

SIGNAL-TO-NOISE RATIO MEASUREMENTS

Measurement	Range	Accuracy
Unweighted SNR	26 dB to 65 dB 66 dB to 72 dB	±1.0 dB ±2.5 dB
Luminance Weight SNR	26 dB to 72 dB	±1.0 dB
Chrominance Weighted SNR	26 dB to 72 dB	±1.0 dB

The Option 04 program is stored in PROMS on two circuit boards which plug into the 1980 base unit.

ANSWER 1980 VIDEO MEASUREMENTS - REPORT LOG

27-APR-83 11:44:16

				VIOLATED LIMITS LOWER	UPPER	
CHAN A (SIGNAL A)	11:44:16	APL = 41 %				
LINE SYNC DURATION	4.63	USEC				
SYNC RISE TIME	185.0	NSEC				
SYNC FALL TIME	195.0	NSEC				
SYNC AMPL ERROR	4.8	%				
FRONT PORCH	------	USEC	**	.5	3.0	NO BLANKING EDGE
LINE BLANKING	------	USEC	**	9.1	16.0	NO BLANKING EDGE
BROAD PULSE SEP	4.7	USEC				
EQUALISING PULSE	2.33	USEC	*	2.34	2.36	
LINE SYNC-TO-BURST	5.61	USEC				
BURST DURATION	2.24	USEC				10 CYCLES
BURST AMPL ERROR	9.1	%	*	-3.0	3.0	
BAR TILT	.7	%				
BAR RISE TIME	190.0	NSEC				
BASELINE DISTORTN	-1.9	%	*	-1.0	1.0	
2T PULSE/BAR ERROR	-16.5	%	*	-10.0	10.0	
2T PULSE K FACTOR	1.1	% KF	*	0.0	1.0	
LUM NON-LINEARITY	5.9	%	*	0.0	5.0	

Measurement results are displayed in an easy-to-read format indicating the time, signal source, measurement, whether the measured value exceeded caution (*) or alarm (**) limits, and whether the out-of-limits value is better (B) or worse(W) than the previously reported value. This same format is also used for reporting individual measurements when the operator interrupts the monitoring process.

1980 ANSWER Option 05
PAL Monitoring Software

Unattended Monitoring of PAL Video Signals from Studios, STLs, Earth Stations, and Transmitters

Measurement of Signal Timing, Frequency Response, Amplitude, Phase, and Noise Parameters

Waveform Plots for Analysis and Documentation

Remote Operation

Automatic Logging

User Definable Measurement Limits

Operator-Initiated Individual Measurements

Vertical Interval Scan for Test Signal Locations

User-Defined Measurement Groups

With the Option 05 PAL Video Signal Monitoring Software, ANSWER makes automatic or operator-initiated measurements on ITS and full field signals.

Unattended Monitoring
Option 05 will continuously monitor video signals, make user-selected standard measurements, compare them against user-defined limits, and print alarm messages should these limits be exceeded.

Signal Timing, Frequency Response, Amplitude, Phase, and Noise Measurements
The user can apply Option 05 in many different video environments: at transmitters, in studios, at cable head-ends in TV manufacturing facilities and at satellite earth stations. CCIR Rep. 624-1 timing measurements, as well as amplitude and phase measurements on CCIR Rec. 567 ITS, can be made with the amplitude measurement results reported as mV, % of bar, or % of carrier. Blanking level and baseline distortion can be measured and the amplitude/frequency response of various television circuits determined by measuring the amplitude of the first five multiburst frequency packets, referenced to the multiburst flag.

Waveform Plots
Waveforms can be plotted on local or remote graphic devices for further analysis. Any portion of the waveform can be expanded to fill the screen and examine small distortions in detail. Hard copies of the waveform plots are useful for support documentation and trend analysis.

Remote Operation
The Option 05 program can be operated from a remote terminal over voice grade telephone lines. With Option 12 (Autocall) it will automatically dial up a remote terminal under user-specified conditions e.g., an out-of-limits signal.

Automatic Logging
A user-defined set of measurements will automatically be made and the results printed at operator-scheduled times.

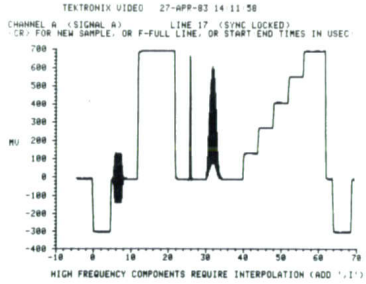
User-Definable Measurement Limits
The user can specify inner (caution) and outer (alarm) limits for each measurement parameter and different sets of limits for the two 1980 video input channels.

Operator-Initiated Individual Measurements
Monitoring can be interrupted at any time to make one or more individual measurements, once or repeatedly. The numeric results are printed. Combined with the capability to plot waveforms, this makes ANSWER a powerful trouble-shooting instrument.

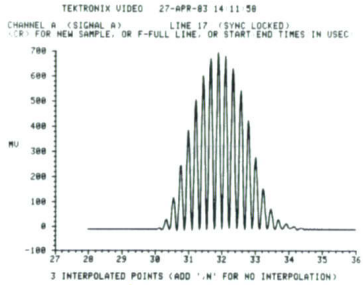
Scan the Vertical Interval for Test Signal Locations
CCIR Rec. 567 ITS, EBU color bars, multiburst, Zero Carrier, teletext, or quiet lines can be located by using the Option 05 program to scan the vertical interval, and "memorize" the field and line locations of these well-defined waveforms. The locations found are used in subsequent sampling. Also, the waveforms on lines 9 through 23 and 322 through 336 can be plotted enabling the operator to visually locate the Zero-Carrier pulse, teletext, or a quiet line.

User-Specified Measurement Groups
New commands can be created, each of which "stands for" a sequence of Option 05 commands. This enables unique Option 05 command sequences to be developed which perform a measurement task that is tailor-made for the user's application. Thereafter, only the user-coined command name needs to be typed to initiate the series of measurements.

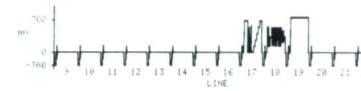
NEW



Any line of video can be graphed on graphic display terminals and hard-copy devices locally, or at remote locations



Any portion of a line can be expanded for detailed analysis



Waveforms on lines 9 through 23 (or 322 through 336) can be graphed for quick visual recognition of vertical interval line usage

CHARACTERISTICS

The measurement specifications cited in this section are valid only within the following environment limits: Temperature range of 0°C to 50°C, with a minimum warm-up time of 20 minutes. The following listing gives each measurement and its associated range and accuracy.

All measurement accuracies are valid over the entire dynamic range, and are specified for unweighted signal-to-noise ratios of both 46 dB and 60 dB on the incoming signal.

LINE BLANKING TIMING MEASUREMENTS

Measurement	Range	Accuracy	
		at 46 dB	at 60 dB
Color Burst Duration	6 to 13 cycles	±0.2 cycle	±0.2 cycle
Front Porch Duration	0.5 µs to 3 µs	±30 ns	±25 ns
Line Blanking	9 µs to16 µs	±40 ns	±30 ns
Line Sync Rise and Falltimes	0.14 µs to 0.3 µs 0.3 µs to 0.8 µs	±20 ns ±40 ns	±15 ns ±30 ns
Line Sync	1.4 µs to 6.6 µs	±20 ns	±15 ns
Sync-to-Start of Burst	2.2 µs to 8.0 µs	±30 ns	±20 ns

FIELD BLANKING TIMING MEASUREMENTS

Measurement	Range	Accuracy	
		at 46 dB	at 60 dB
Equalizing Pulse Duration	1.4 µs to 20 µs	±25 ns	±20 ns
Broad Pulse Separation	1.4 µs to 20 µs	±25 ns	±20 ns

OTHER TIMING MEASUREMENTS

Measurement	Range	Accuracy	
		at 46 dB	at 60 dB
Bar Risetime	0.14 µs to 0.3 µs 0.3 µs to 1.0 µs	±25 ns ±60 ns	±15 ns ±20 ns

AMPLITUDE AND PHASE MEASUREMENTS

Measurement	Range	Accuracy	
		at 46 dB	at 60 dB
Sync Amplitude Error	+100% to −50%	±1.25%	±1.0%
Sync Amplitude Error (with Sound-in-Sync)	+100% to −50%	±1.25%	±1.0%
Burst Amplitude Error	+80% to −50%	±1.5%	±1.4%
Chrominance Reference Amplitude Error	−80% to +50%	±1.5%	±1.25%
Luminance Bar Amplitude Error	+30% to −70%	±0.75%	±0.6%
Luminance Bar Amplitude	200 to 900 mV	±5.5 mV	±4.5 mV
Bar Tilt Error	0% to 40%	±0.7%	±0.4%
Blanking Level	0% to 100% of Zero Carrier	±1%	±1%
2T Pulse K-factor	0% to 10% Kf	±0.7% Kf	±0.4% Kf
Chrominance-Luminance Gain Inequality	±75% of bar amplitude	±1.4%	±1.2%
Chrominance-Luminance Delay Inequality	±300 ns	±35 ns	±25 ns
Chrominance-Luminance Intermodulation	±50%	±0.5%	±0.3%
Differential Gain	0% to +50%	±1%	±0.3%
Differential Phase	0° to +180°	±0.6°	±0.3°
Luminance Nonlinear Distortion	0% to 50%	±0.7%	±0.35%

FREQUENCY RESPONSE MEASUREMENTS

Measurement	Range	Accuracy	
		at 46 dB	at 60 dB
Multiburst Flag Amplitude	15% to 125% of bar	±0.5%	±0.2%
Multiburst Amplitude (first five packets)	0% to 200% of flag	±3.0% (±3.5% on 4.8 MHz packet)	±2.5% (±3.5% 4.8 MHz packet)

LINEAR WAVEFORM DISTORTION MEASUREMENTS

Measurement	Range	Accuracy	
		at 46 dB	at 60 dB
Baseline Distortion	±50% of bar	±0.75%	±0.5%
2T Pulse/Bar Ratio Error	+25% to −90%	±1.5%	±1.25%

LOW FREQUENCY ERROR

Measurement	Range	Accuracy	
		at 46 dB	at 60 dB
Low Frequency Error	0% to 25%	±1.0%	±0.8%

NOISE MEASUREMENTS

Measurement	Range	Accuracy
Continuous Random Noise (weighted)	34 dB to 73 dB 74 dB to 80 dB	±2.0 dB ±2.5 dB
Signal-to-Unweighted Random Noise Ratio	26 dB to 65 dB 66 dB to 72 dB	±1.0 dB ±2.5 dB

The Option 05 program is stored in PROMS on two circuit boards which plug into the 1980 base unit.

1980 ANSWER Option 06
Dual Standard Applications Software

Measurements on PAL and NTSC Video Signals

All Features Present in the 1980 ANSWER Options 04 and 05

With the Option 06 Dual Standard Applications Software, ANSWER can make automatic or operator-initiated measurements on both PAL and NTSC video signals. The video standard in use on the incoming video signals is specified by the user, and thereafter Option 06 makes all measurements accordingly.

This program combines all features of Option 04 (NTSC Video Monitoring) and Option 05 (PAL video monitoring) into one program. The characteristics remain the same as in those programs.

The Option 06 program is stored in PROMS on two circuit boards which plug into the 1980 base unit.

ORDERING INFORMATION

For Base Unit Plus Software, Order:

1980 ANSWER with Option 01
NTSC Applications Software $26,000

1980 ANSWER with Option 04
NTSC Monitoring Software $26,800

1980 ANSWER with Option 05
PAL Monitoring Software $26,800

1980 ANSWER Option 06 ..... $29,500
Option 12 — Automatic Call Equipment ..... +$500

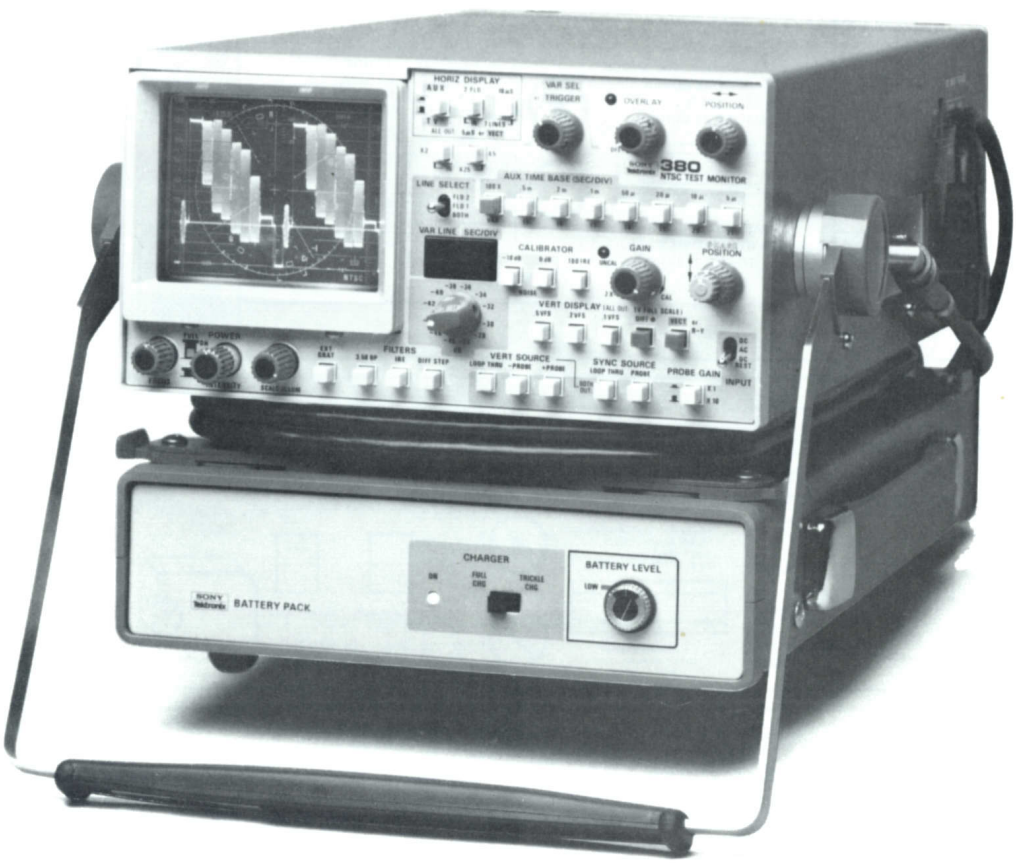
For Software Only, Order:

1980 F04 ..... $5,800
1980 F05 ..... $5,800
1980 F06 ..... $8,500

OPTIONAL ACCESSORIES

Service Kit — Order 067-1115-00 ..... $3,000

VIDEO MEASUREMENT TEST



380 Test Monitor with optional battery pack

380/381

- Ac or Dc Operation
- NTSC or PAL Versions
- Bright CRT
- Precise Frequency Response
- Noise Measurement
- Probe Input
- Line Selection

The 380 and 381 Test Monitors are compact, lightweight instruments optimized for portability in many television environments, including maintenance, engineering and EFP. The 380 is used in NTSC systems, the 381 in PAL systems. Both units have the combined capabilities of a precision waveform monitor, vectorscope, and general purpose oscilloscope.

The flexibility of the 380 and 381 makes them an ideal choice for a variety of applications. Video technicians, for example, find them invaluable when maintaining such video equipment as VTRs, cameras, and transmitters, particularly in remote locations. With an auxiliary oscilloscope trigger, sweep, and display, the 380 and 381 are also well-suited for maintaining other equipment, such as audio systems, servos, and control and switching systems.

Video engineers make good use of their extensive measurement capabilities, which include differential phase and gain, tangential noise, vertical interval line selection, short-time distortion, trace overlay, and a 0.5% calibrated amplitude comparator, to name only a few. The operator can choose to make video measurements from a 75-ohm or probe input.

Production personnel take advantage of the monitor's bright display and portability during remote productions, on EFP carts, in production vans, and in other remote applications. Pushbutton controls bring up standard horizontal (line) and vertical (field) waveform displays. A vectorscope display provides easy monitoring of color bars and chroma.

Waveform Monitor

In the waveform monitor mode, the 380 and 381 have the flat frequency response (±2% to 5 MHz) required for measuring or monitoring a video signal. The monitors provide a full set of input filters, including chroma band pass, IRE or low pass, and differential step. The input signal can be ac or dc coupled, or dc restored, and switched between a loop-thru and probe input, with independent sync source selection. Calibrated vertical displays at 0.1, 0.2, 0.5 and 1.0 volts full scale, along with a variable gain control, provide a full range of amplitude control.

Digital and variable vertical interval line selection allows any individual line in any frame to be displayed and identified by line and field number. All displays can be expanded horizontally 2, 5 or 25 times for increased clarity of fast signal components.

Vectorscope

In the vectorscope mode, the vector display of either a full field or vertical interval signal can be selected. The display can be referenced to either the displayed signal or an external composite color video signal.

A decoded R-Y (or V) line sweep display is available, and the 381 is switchable between a PAL or NTSC type vector display.

Oscilloscope

In the oscilloscope mode, a selectable time base from 50 milliseconds per division to 0.2 microseconds per division, along with negative or positive slope trigger for nonvideo signal observation are provided.

Battery Pack

An optional battery pack (Option 11) attaches to the bottom of the 380/381 for complete portability, providing more than two hours of continuous operation. A convenient recharger is built into the pack. The battery pack is quickly replaceable for long term remote operation.

CHARACTERISTICS

Deflection Factor

	Loop Thru/Probe X10	Probe X1
1 V	≤1%	≤2%
0.5 V	≤3%	≤4%
0.2 V	≤3%	≤4%
0.1 V	≤3%	≤4%

Variable Volts Full Scale Range — X0.2 (±4%) to ≈1.4.

Maximum Input Signal — Loop Thru: ±1.5 V dc + peak V ac, (dc coupled). ±2.0 V p-p at any APL (ac coupled). Probe X1: ±5 V dc + peak V ac <1 kHz (Signal Out not terminated). Probe X10: ±0.5 V dc + peak V ac, <1 kHz (Signal Out not terminated).

Maximum dc Output into 75 Ω (Signal Out) — ±0.5 V dc.

Frequency Response — FLAT (from 50 kHz reference). Loop Thru (Including Signal Out): +10°C to +30°C is 50 kHz to 5 MHz ±2%; 5 MHz to 10 MHz +2%, −5%. Loop Thru (Including Signal Out): +0°C to +50°C is 50 kHz to 5 MHz ±3%; 5 MHz to 10 MHz +3%, −5%. Probe: Typically <1 dB down to 15 MHz; <2 dB down to 18 MHz; <3 dB down to 20 MHz. IRE (380): Conforms to IEEE Standard 205, 1972. LUM (381): <3 dB down at 1 MHz; at least 40 dB down at 4.43 MHz. 3.58 MHz (380): ±1% of Flat at 3.58 MHz, bandpass ≈600 kHz. 4.43 MHz (381): ±1% of Flat at 4.43 MHz, bandpass ≈800 kHz. Diff STEP: Attenuation ≤2 dB from 0.4 to 0.5 MHz; ≥20 dB at 14 kHz and 2 MHz; ≥40 dB at 3.58 MHz and 4.43 MHz.

Linear Waveform Distortion (2T) — Pulse Aberrations: ≤1.0% of applied pulse amplitude within 1 μs of HAD points. 25 μs Bar Tilt: ≤1%. Field Squarewave Tilt: ≤1%. Pulse to Bar Ratio: 0.99 to 1.01:1 (at 1.0, 0.5 or 0.2 V full scale). 0.98 to 1.02:1 (at 0.1 V full scale).

Nonlinear Waveform Distortion — Differential Gain Displayed: ≤0.5% at any APL. Signal Out: ≤1.0% of any APL. Differential Phase Displayed: ≤0.25° at any APL. Signal Out: ≤0.5° at any APL.

Return Loss — Loop Thru Input: ⩾40 dB, dc to 5 MHz.

Calibrator Accuracy — 100 IRE: ⩽0.5%. Noise: 0 dB = 700 mV ±5%. Step Accuracy: ⩽1 dB. Instrument S/N: ⩽−60 dB.

Probe — Input Resistance: 1 MΩ, ±2%. Input Capacitance: ≈24 pF. Maximum Safe Input Volt: 250 V dc + Peak V ac 1 kHz or less.

1 V Cal Out — Output Voltage: 1.000 V ±0.005 V. Waveform: Squarewave. Frequency: ≈1 kHz. Output Impedance: <1 Ω.

Vertical Geometry — ⩽0.15 div error.

Horizontal Geometry — ⩽0.15 div error.

Sweep Timing Accuracy and Linearity (Over Center 10 div)
TV Time Base — At 5 μs timing 1%, linearity 2%; at 10 μs timing 2%, linearity 3%.

Auxiliary Time Base — Timing 4%, linearity 5%.

Magnified Timing and Linearity — X2, X5 and X25: Add 1%, error for center ten divisions of unmagnified sweep.

Two Field Sweep Length — 12.7 div; ±0.5 div.

Field Selector — Positive selection of Odd (2 and 4), Even (1 and 3).

Line Selector — Variable Range: From ≈ line 17 of the selected field to 25% into adjacent field; lines intensified by the strobe in two Field display. Digital (380): Selects line 15 to line 21. Digital (381): Selects line 16 to line 22 and line 329 to line 335.

Sync Input Requirements — TV Sync: 200 mV p-p to 2 V composite video. Auxiliary Sync: ⩽20 mV at 50 Hz; ⩽10 mV at 50 kHz; ⩽50 mV at 5 MHz.

Chrominance Bandwidth — Upper −3 dB Point: fsc +500 kHz ±100 kHz. Lower −3 dB Point: fsc −500 kHz ±100 kHz.

Vector Phase Accuracy — ⩽2°

Subcarrier Regenator — Pull-in Range: Within 50 Hz of fsc. Pull-In Time: ⩽1 s. Phase Shift with Subcarrier Frequency Change: <1° typically from fsc to fsc +10 Hz, or from fsc to fsc −10 Hz; <2° typically from fsc to fsc +20 Hz, or from fsc to fsc −20 Hz. Phase Shift with Burst Amplitude Change: ⩽2° from nominal burst amplitude to ±6 dB. Phase Control Overall Range: ±30° (380), at least 80° (381). Vector Gain Accuracy: ⩽2 IRE. Differential Phase Accuracy: ⩽10% of measurement ±0.3°.

Optional Battery Pack — Power Output: 11 to 12 V dc; 6 A hours (0°C to +40°C); 3 A maximum. Operating Time: >2 hours. Charge Time: 14 to 16 hours (0°C to +40°C). Storage Temperature: (−40°C to +60°C). Power Consumption: 30 W maximum.

Mains Voltage Range — 115 V ac: 90 V ac to 132 V ac. 230 V ac: 180 V ac to 250 V ac.

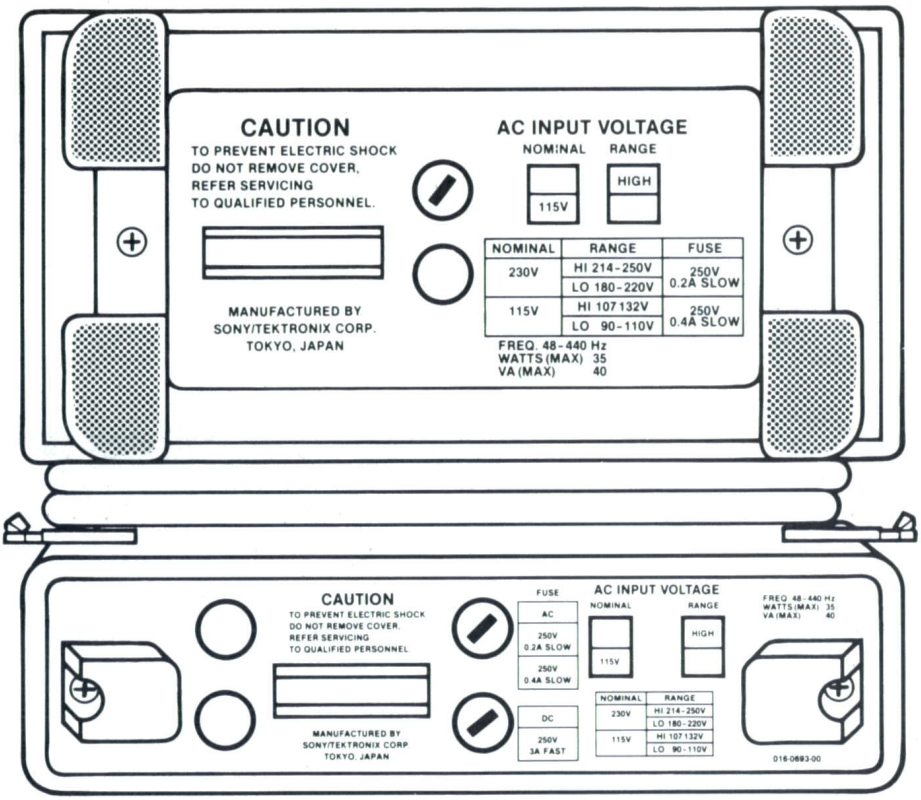
Power Consumption — 35 W.

Mains Frequency — 48 Hz to 440 Hz.

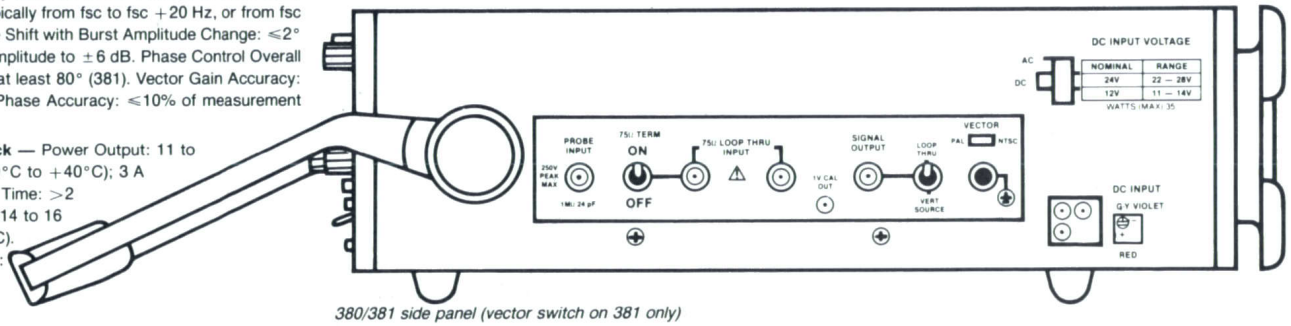
ENVIRONMENTAL CHARACTERISTICS

Temperature — Operating: 0°C to +50°C. Nonoperating: −25°C to +75°C.

Altitude — Operating: To 4500 m (15,000 ft). Nonoperating: To 15 200 m (50,000 ft).



380/381 and optional battery pack back panels



380/381 side panel (vector switch on 381 only)

PHYSICAL CHARACTERISTICS (380/381)

Dimensions	mm	in
Width, w/handle	237	9.5
Height	112	4.5
Depth, handle not extended	372	14.9
Depth, handle extended	482	19.3
Weight	**kg**	**lb**
Net	5.5	12.1

BATTERY PACK

Dimensions	mm	in
Width	209	8.4
Height	68	2.7
Depth	353	14.1
Weight	**kg**	**lb**
Net	4.0	8.8

INCLUDED ACCESSORIES

Probe package (010-6149-03); phase reference switch box (015-0438-00); external dc cable assembly (161-0094-01); carrying case (016-0663-02); 3 A, 250 V fast fuse (159-0015-02); 1.5 A, 250 V fast fuse (159-0156-00); 0.2 A, 250 V slow fuse (159-0180-00); 0.4 A, 250 V slow fuse (159-0179-00); cover carrying case (200-2260-00); carrying strap assembly (346-0131-01); viewing hood (016-0297-00); manual.

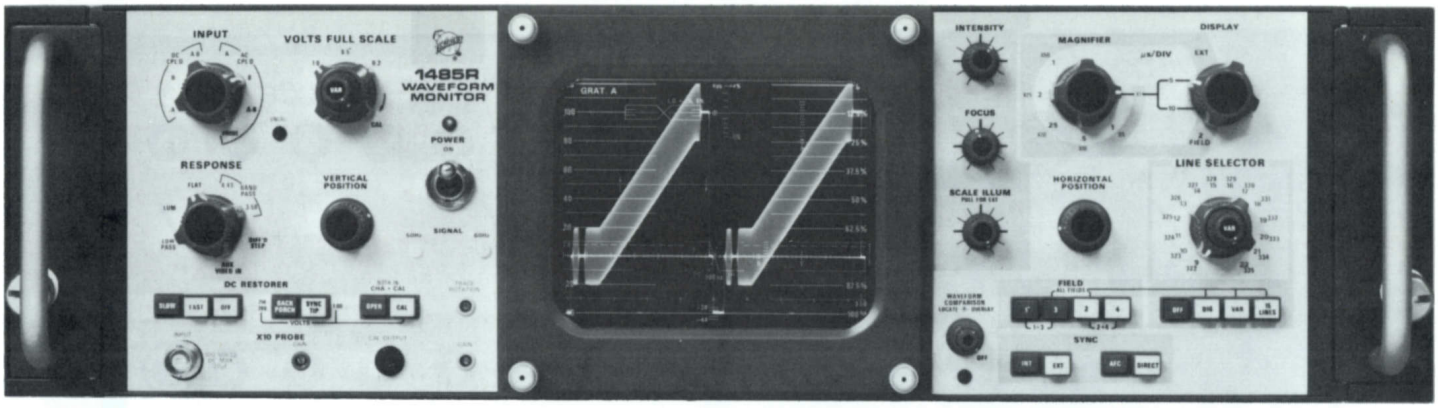
ORDERING INFORMATION

380 Test Monitor
(For NTSC Systems) **$5,220**
381 Test Monitor
(For PAL Systems) **$5,220**
Option 11 — With Battery Pack Included ..... **+$845**
Option 89 — Required for Export Orders ..... **NC**

OPTIONAL ACCESSORIES

Battery Pack — Order 016-0693-00 (for 380) **$875**
Order 016-0693-04 (for 381) **$875**
Camera Adaptor — (mounts the C-30BP camera)
Order 016-0327-01 ..... **$170**

The SONY®/TEKTRONIX® 380/381 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 380/381 is available from Tektronix, Inc., its marketing subsidiaries and distributors.



1485R Option 01 PAL/NTSC Dual Standard Waveform Monitor (Rackmount)

1480

Bright CRT Especially Suitable for Vertical Interval Testing

Advanced Measurement Modes

Amplitude Measurement Accuracy Approaching 0.2%

Digital Selection of Line and Field

Probe Input Option

15-Line Display for VTR Applications

The 1480 Series waveform monitors have excellent amplitude measuring accuracy and many unique operating modes that enable you to work more precisely and accurately. The monitoring needs of CCU, VTR, control room, transmission facilities, transmitter, and special systems are met by the use of 1480 Series waveform monitors. The 1485C and 1485R PAL/NTSC dual standard monitors (see photos) represent the essentials of all eight monitors in the 1480 Series. The differences between the monitors in the series are essentially confined to what lines in the vertical interval are selectable, what filters are selectable in the response mode, and in the field selection modes. Dual-Standard Monitors recognize the signal standard in use automatically and indicate that standard with front panel indicators.

Vertical Interval Testing

Two features are needed in a waveform monitor used for vertical interval testing: A bright CRT and line selection.

The CRT in the 1480 series is bright enough that one VITS (Vertical Interval Test Signal) selected out of four fields can be seen with ease even in a well-lighted area.

Two modes of line selection are provided in the 1480 Series waveform monitors: digital and variable.

Digital selection of field and line assures positive identification of displayed information. For example when you select line 18 of field 2 it is certain that what you will see is line 18, field 2. Digital techniques will not allow an incorrect selection.

Variable selection of other lines is provided for full field signal analysis. In all line selection modes a line intensifying strobe is provided with video for picture monitor displays. A second line strobe output is provided to strobe 520A Series vectorscopes, etc. Intensified two-field displays on the 1480 help you locate the line or lines selected.

High Amplitude Measurement Accuracy

In recognition of the need for more accuracy the 1480's give you the capability to make amplitude measurements with accuracy approaching 0.2% using a precision display offset. A proven video measurement technique, offsetting displays with an amplitude standard is an easy-to-use method that achieves accuracy by eliminating parallax and transfer errors. Transfer errors are eliminated because you compare your signal to a precise one volt standard rather than to graticule calibration. Measurements made with comparison techniques also have a high order of consistency and repeatability. When your signal precisely matches the standard your signal amplitude will be determined to the value and accuracy of the offset. The tolerance of the internal calibration signal used as the standard is 0.2%.

Trace Overlay

The 1480's can actually overlay a later segment of a display on the earlier segment. Superimposing waveforms over other waveforms allows exact comparison of levels. With overlay you can exactly compare the elements of complex vertical interval test signals.

Probe Option

The 1480's make convenient high impedance probing available with a probe option. This option provides an input that accepts most Tektronix probes. As a part of this option a probe compensation waveform test point is provided (A ten-times amplifier keeps full screen sensitivities while using X10 attenuator probes.)

CHARACTERISTICS

VERTICAL DEFLECTION

Inputs — Input A and B are 75 Ω high impedance loop-through. Return loss is ⩾40 dB from dc to 5 MHz in a 75 Ω system. Aux Video Input is internally terminated in 75 Ω. Return loss is ⩾34 dB from dc to 5 MHz.

Scale Factor — A and B input calibrated 1.0 V ±7 mV, 0.5 V ±15 mV, 0.2 V ±7 mV. (0.05 V ±2.5 mV Option 06) volts full scale. Variable: Range for each scale factor at least +40% to −50%. Aux Video Input 1.5 dB gain.

Maximum Input Voltage — 2 V p-p (ac coupled), ±1.5 V dc + peak ac (dc coupled).

Frequency Response

FLAT: 50 kHz to 5 MHz ±1% (1.0 V F.S., VAR in detent). 5 MHz to 8 MHz +2, −3%, 8 MHz to 10 MHz +2, −6%. Typically within +2, −15% to 18 MHz and typically −3 dB at 20 MHz.

Low Pass: Attenuation ⩾14 dB, 500 kHz and above. 3.58 MHz Bandpass: Amplitude within ±1% of amplitude in Flat response position. Bandpass ≈600 kHz. 4.43 MHz Bandpass: Amplitude within ±1% of amplitude in flat response position. Bandpass ≈800 kHz. IRE: Conforms to IEEE Standard 205, 1972.

Linear Waveform Distortion

Pulse/Bar Ratio: ±1%. For NTSC or PAL 2T Pulse or NTSC T Pulse.

Short Time: Preshoot, overshoot, ringing ⩽1% of NTSC or PAL T Pulse and Bar.

Line Time: Tilt or rounding ⩽1.0%. Field Time: (Ac coupled) ⩽1%.

Nonlinear Distortion — Differential Gain: ⩽0.5%.

Dc Restorer — Keyed type, may be turned off. Clamping point: Back Porch/Sync Tip.Time Constant: FAST reduces mains hum ⩾26 dB, SLOW reduces mains hum <0.9 dB.

Calibrator — Amplitude selected by dc Restorer switch. Sync Tip: 1 V ±0.2%. Back Porch: 714 mV or 700 mV ±0.5%.

HORIZONTAL DEFLECTION

Time Base — 5 μs and 10 μs timing accuracy ±2% (center 10 divisions); 5 μs and 10 μs linearity ±1% (center 10 division).

External Sync Input — Two loop-through high impedance, with ⩾46 dB return loss in a 75 Ω system. Inputs are slaved to A and B input or to A external sync input only.

External Sync Input Requirements — 400 mV to 2 V composite video or 200 mV to 8 V composite sync.

Field Selector — Positive selection of Field 1 or 2 in the NTSC system. Positive selection of 1, 2, 3, 4, or 1 & 3, 2 & 4 in the PAL systems.

Line Selector — Dig: Selects lines 9 to 22 NTSC, line 9/322 to line 22/335 PAL, line 9/272 to line 22/285 PAL-M. Var: Approx line 20 of the selected field to line 4 of the next related field. 15 lines: Identical to Var, except 15 successive lines are displayed.

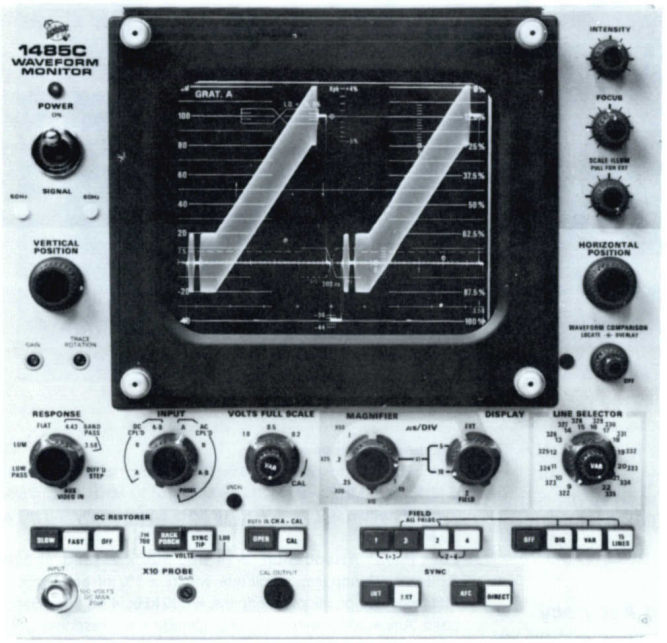
Sync — AFC horizontal frequency range is 15.75 kHz ±200 Hz. Maximum Jitter with Respect to Input Sync: 10 ns with 4 V RMS hum (30 ns with the addition of −36 dB white noise). Direct horizontal frequency up to ⩽20 kHz. Maximum Jitter with Respect to Input Sync: 12 ns with 4 V RMS hum (90 ns with the addition of −36 dB white noise).

OUTPUTS

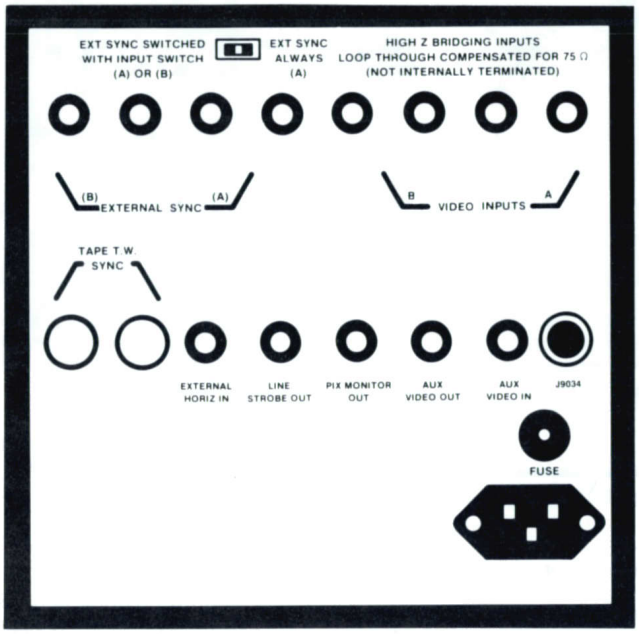
Line Strobe — TTL amplitude pulse. Pulse coincident with line or lines selected by VAR, 15 LINE or DIG modes of DISPLAY switch.

Picture Monitor — Output of incoming video with Line Strobe added. Output impedance is 75 Ω. Output gain adjusted to unity with respect to A and B video input.

Aux Video — Output of incoming video. 75 Ω output impedance. Gain adjustable to unity with respect to A and B video input.



1485C PAL/NTSC Waveform Monitor (Cabinet)



1485C Rear Panel

OTHER CHARACTERISTICS

RGB/YRGB Staircase Input — ≈12 V for 12.7 divisions deflection. RGB sweep length internally selected for 1/3 normal sweep. YRGB sweep length internally selected for 1/4 normal sweep length.

Mains Voltage — Ranges 100, 110, 120, 200, 220, 240 V ac ±10%. Frequency 48 Hz to 62 Hz, maximum power consumption 75 W. At factory, 1480, 1482 preset for 110 V ac. 1481, 1485 preset for 220 V ac.

CHARACTERISTICS (OPTION 01)

10X Probe Channel — Scale Factor: 1 V, 0.5 V, 0.2 V full screen with 10X attenuator probe. Gain Range: ±10%. Tilt: ≤5% on 50 Hz. Squarewave High Frequency Response: ±3%, 25 Hz to 5 MHz. Referenced to 50 kHz. Input Resistance 1 MΩ, ±2%, not including probe. Input RC Product: 20 μs, ±1%, not including probe. BNC connector accepts most Tektronix probes.

10X Probe Calibrator — Output voltage 1,000 V ±0.005 V or 0.995 to 1.005 V.

CHARACTERISTICS (OPTION 06 & 07)

Duration — 4 to 12 s, variable with front panel control.

Linearity — ±5% of full-screen over the length of the sweep.

Indicator — Front panel indicator on when slow sweep is operating but sweep is not running.

Triggering Signal — APL change ≤10% to 90% (Bump or Bounce), front panel selectable for either + or − level change.

Sensitivity — 400 mV to 2 V p-p composite video with APL change.

Rate — ≥0.2 Hz, free-runs at rates <0.2 Hz or with no triggering signal.

Input — Internal or External.

50/60 Hz Squarewave Triggering — Sensitivity: 400 mV p-p minimum to 3 V p-p maximum. Input Impedance: ≈10 kΩ ac coupled (Rear Panel loop-through connectors not return loss compensated.)

PHYSICAL CHARACTERISTICS

	1480C		1480R	
Dimensions	**mm**	**in**	**mm**	**in**
Width	216	8.5	482	19.0
Height	210	8.25	133	5.25
Depth	430	16.9	457	18.0
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net	9.8	21.5	11.2	24.6
Shipping	24.1	53.1	24.1	53.1

INCLUDED ACCESSORIES

Two BNC right angle adaptors (103-0031-00); One pair rackmount ext DWR Slides (351-0195-01); various external graticules (see matrix below); manual.

External Graticules w/Tek P/N	1480 R/C	1481 R/C	1482 R/C	1485 R/C
Blank 331-0393-00	x	x	x	x
NTSC Composite 331-0393-01				x
CCIR 331-0393-02				
CCIR K Visual 331-0393-05		x		x
CCIR K Photo 331-0393-07		x		x
GRAT A Visual 331-0393-08				x
GRAT B Visual 331-0393-18	x			x
GRAT A Photo 331-0393-10				x
GRAT B Photo 331-0393-17	x			x

ORDERING INFORMATION

1480C NTSC Waveform Monitor **$5,760**
1480R NTSC Waveform Monitor **$5,760**
1481C PAL Waveform Monitor*1 ..... **$5,865**
1481R PAL Waveform Monitor*1 ..... **$5,865**
1482C PAL-M Waveform Monitor **$6,170**
1482R PAL-M Waveform Monitor **$6,170**
1485C PAL/NTSC Dual Standard Waveform Monitor*1 ..... **$5,070**

1485R PAL/NTSC Dual Standard Waveform Monitor*1 ..... **$6,070**

Option 01 — 1 MΩ, 20 pF Probe Input (not available with Option 06, probe not included) ..... **+$275**
Suggested Probe: P6108 10X Probe 2 m (010-6108-03); or 3 m (010-6108-05) **$100**

Option 06 — 124 Ω WECO Style Inputs (1480R only) ..... **+$1,885**

Option 07 — Slow Sweep*2 (Option 07 performance included with Option 06. Do not order with Option 06) . **+$465**

Option 08 — SECAM Field Identification (1481C, 1481R, 1485C and 1485R only) ..... **+$315**

**1 1481C/R, 1485C/R meets European Broadcast Union Tech. 3221-E, Guiding Principles for design of Television Waveform Monitors.*

**2 Option 07 satisfies EBA Tech 3321-E § 3.2.2.*

OPTIONAL ACCESSORIES

Mounting Cradles — A cradle assembly, with associated bezel, allows the 1480C Waveform Monitor to be mounted alongside a 9 in Conrac Picture Monitor in a standard 19 in rack. A cradle and bezel are also available for mounting two 1480C's side-by-side.

Cradle Assembly — Requires 8¾ inch rack space. Order 014-0020-00 ..... **$225**

Bezel — For mounting 1480C on operator's left and SNA-9 picture monitor on right Order 014-0023-00 ..... **$300**

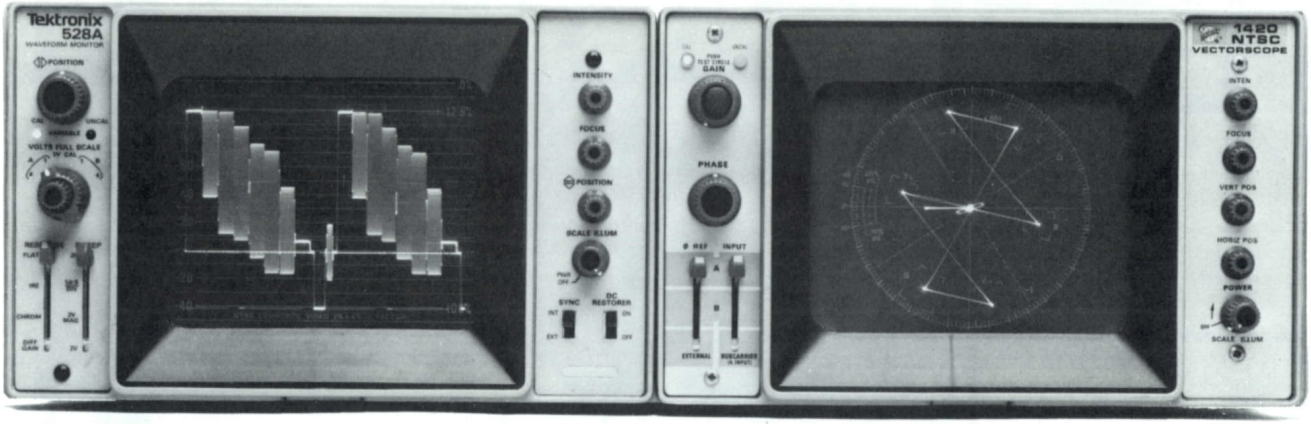
Bezel — For mounting 1480C on operator's right and SNA-9 picture monitor on left Order 014-0024-00 ..... **$225**

Bezel — For two 1480C's side-by-side. Order 014-0022-00 ..... **$200**

1480R Cradle Assembly — For mounting the 1480R in a WECO backless rack Order 426-0309-00 ..... **$40**

Field Case — (As used in Option 02 cabinet version only). Order 016-0084-00 ..... **$120**

Trace Recording Cameras — Both the Tektronix C-53P and the C-59AP can be used. The C-53P gives the largest image possible on Polaroid pack film. The C-53P requires a battery pack (016-0270-02) and camera adaptor (016-0342-00). The C-59AP is less expensive but produces a smaller image on the film. The C-59AP requires a camera adaptor (016-0224-01). See camera section of this catalog.



528A Waveform Monitor mounted side by side with a 1420 Vectorscope in optional rack adaptor.

528A/1420 Series

Parallax-Free Internal Graticule

Half Rack Width

Proven Performance

Available in NTSC, PAL, PAL-M Models

The 528A Waveform Monitor and 1420 Series vectorscopes and X-Y monitors provide complete monitoring of your video signal. One 528A and one 1420 Series monitor mounted side by side in the optional rack adaptor provide a continuous display of both the luminance and chrominance information of your video signal, whether your signal is in the NTSC, PAL, PAL-M or SECAM format. (The 1424 X-Y Display Monitor provides a vector display of the chroma portion of the television signal by utilizing the decoder in a Tektronix 650HR Series picture monitor.)

These monitors are ideally suited for use in camera, VTR, video production and post production monitoring applications. They all have simple-to-understand and easy-to-use controls.

CHARACTERISTICS (528A)

Inputs — Two Rear Panel BNC Connectors (A and B): Provide two 75 Ω loop through connectors (normally ac coupled but may be easily modified for dc coupling).

Video Output — The displayed signal is provided at the Video Out rear panel connector.

Dc Restoration — Slow acting back porch dc restoration.

Calibrator — An internal calibration signal provides a convenient reference to verify the deflection factor. Calibrator amplitude is 1.0 V p-p ±1%.

TIME BASE

Provides four time base operating modes; baseline visible in each mode with no external video or sync inputs.

EXTERNAL SYNC

Input Signal Levels — 1.5 to 4.5 V p-p (composite sync will synchronize sweeps).

YRGB AND RGB

The 528A can be used with color camera processing amplifiers that provide the necessary signal switching and staircase signals.

CHARACTERISTICS (1420, 1421, 1422)

Chrominance Bandwidth — Upper −3 dB Point: Fsc +550 kHz ±100 kHz; Lower −3 dB Point: Fsc −550 kHz ±100 kHz.

Vector Phase Accuracy — Within 1°.

Phase Control Range — 360° continuous rotation with goniometer.

Input Amplitude Range — 1 V ±6 dB.

Front Panel Gain Control Range — Unity to +15.12 dB; Unity to −6 dB.

Input Return Loss — At least 46 dB to 5 MHz.

Differential Phase — 1° or less.

Differential Gain — 1% or less.

CHARACTERISTICS (1424)

VERTICAL AND HORIZONTAL DEFLECTION SYSTEMS

Deflection Factor — Vertical (Y): 0.100 V/cm ±2%. Horizontal (X): 0.100 V/cm ±2%.

Input R and C — 100 kΩ, within 10%, paralleled by ⩽30 pF.

Bandwidth (X and Y) Amplifiers — ⩾500 kHz.

Z AMPLIFIER

Input Requirements — Input Signal: Analog input, dc to 500 kHz over a 0.0 V to +1 V range. (Linear amplifier modulates writing beam.)

Input R and C — 100 kΩ, within 10%, paralleled by ⩽70 pF.

AC POWER

Line Voltage Ranges — 99 V ac to 132 V ac and 198 V ac to 250 V ac (528A). 90 V ac to 132 V ac and 180 V ac to 250 V ac (1420 Series).

Typical Power Consumption — 48 W (528A). 45 W (1420, 1421, 1422); 40 W (1424).

Mains Frequency — 48 Hz to 66 Hz.

SAFETY

All 528A Waveform Monitors shipped with case installed are UL 1244 listed and CSA 556B certified. 528A's shipped without a case are UL recognized components.

PHYSICAL CHARACTERISTICS (528A/1420 SERIES)

Dimensions	mm	in
Width	216	8.5
Height	133	5.25
Depth	470	18.5
Weights (528A)	**kg**	**lb**
Net (with accessories)	6.8	15.0
Shipping	10.4	23.0
Weights (1420 Series)	**kg**	**lb**
Net (with cabinet)	7.0	15.5
Net (without cabinet)	5.9	13.0
Shipping	9.1	20.0

INCLUDED ACCESSORIES

9-pin plug connector for 528A (136-0099-01); manual; 75 Ω termination for 1420, 1421, 1422 (011-0102-00).

ORDERING INFORMATION

528A Waveform Monitor (for 525 line) **$2,330**

Option 01 — Without cover ..... **−$30**

Option 02 — With blue protective carrying cabinet ..... **+$65**

Option 03 — Modified for use with 625 line (CCIR) television systems and wired for use with 230 V ac 50 Hz power sources (unless otherwise specified) ..... **NC**

1420 Vectorscope for NTSC, (factory wired for 115 V) **$2,850**

1421 Vectorscope for PAL, (factory wired for 230 V) **$2,950**

1422 Vectorscope for PAL-M, (factory wired for 115 V) **$3,215**

Option 01 — Vectorscope without cabinet ..... **−$30**

Option 02 — Vectorscope with protective carrying cabinet ..... **+$65**

1424 XY Display Monitor for NTSC/PAL **$1,995**

Option 01 — XY Display Monitor without cabinet ..... **−$30**

Option 04 — External SECAM/PAL Graticule, Blank CRT ..... **+$100**

OPTIONAL ACCESSORIES

Side-by-Side Rack Adaptor — Order 016-0115-02 ..... **$180**

Blank Half-Rack Width Panel Assembly — Order 016-0116-00 ..... **$42**

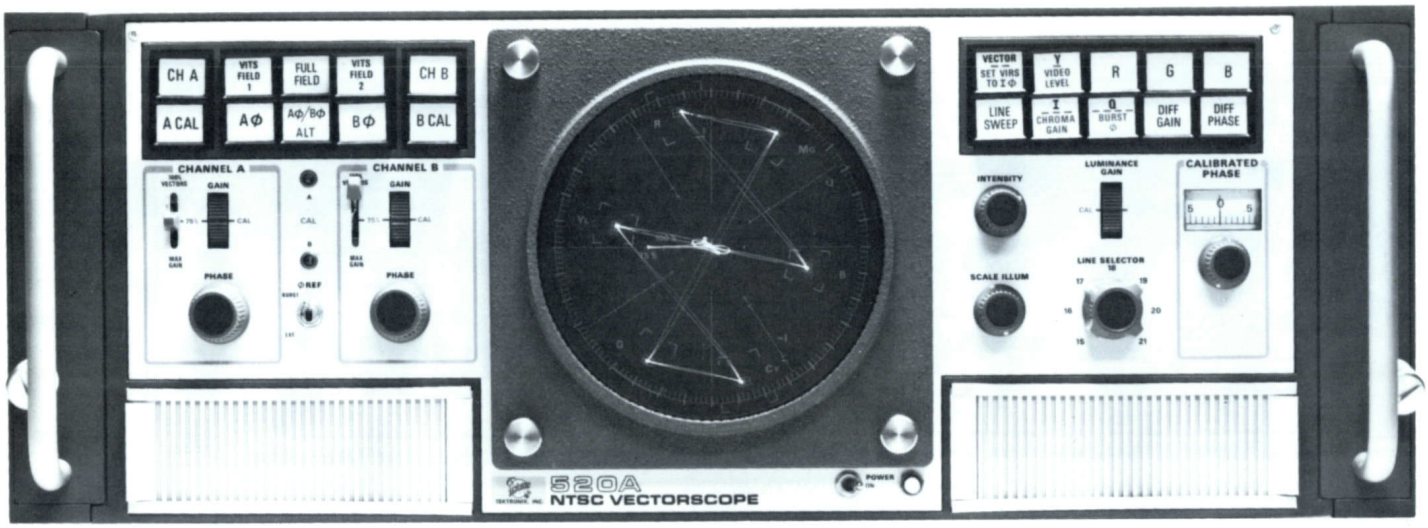
Mounting Cradle — A cradle assembly with associated bezel and mounting brackets allows the 528A Waveform Monitor to be mounted alongside a 8-in Conrac picture monitor in a standard 19-in rack. Order 014-0020-00 ..... **$225**

Bezel and Brackets — Left side mounting of 528A Order 014-0038-00 ..... **$315**

Bezel and Brackets — Right mounting of 528A Order 014-0037-00 ..... **$315**

Graticule External — Scaled in 8 x 10 divs (1420, 1421, 1422, 1424 only) Order 331-0406-01 ..... **$4.65**

Trace Recording Camera — Tektronix C-5C Option 01 recommended for display photos. See camera section of this catalog.



R520A NTSC Vectorscope

520A/521A/522A

Luminance Amplitude

Chrominance Amplitude and Phase

Differential Phase

Differential Gain

The Tektronix 520A Series vectorscopes include three basic instruments available in both cabinet and rackmount configurations. These are the 520A/R520A for NTSC, the 521A/R521A for PAL, and the 522A/R522A for PAL-M.

DISPLAYS

The vector display shows the relative phase and amplitude of the chrominance signal on polar coordinates. To help identify these coordinates, the graticule has points corresponding to the proper phase and amplitude of the primary and complementary colors: R (Red), B (Blue), G (Green), C_Y (Cyan), Y_L (Yellow), and M_G (Magenta).

Any errors in the color encoding, video-tape recording, or transmission processes that change these phase and/or amplitude relationships cause color errors in the television picture. Polar coordinate displays, such as those obtained on the 520A, 521A, and 522A CRT, have proven to be the best method for displaying these errors.

The polar display permits measurement of hue in terms of relative phase of the chrominance signal with respect to the color burst. Amplitude is expressed in terms of the displacement from center (radial length) toward the color point which corresponds to 75% (or 100%) amplitude of the particular color being measured.

The outer boxes around the color points correspond to phase and amplitude error limits (±10°, ±20%). For the 520A (NTSC) the inner boxes indicate ±2.5° and 2.5 IRE units, and correspond to phase and amplitude error limits per EIA specification RS-189, amended for 7.5% setup. For the 521A (PAL) and 522A (PAL-M), the inner boxes indicate ±3° phase angle and ±5% amplitude.

An internally generated test circle, used with the vector graticule, verifies quadrature accuracy, horizontal to vertical gain balance, and gain calibration for chrominance signal amplitude measurements. Two methods of measuring phase shifts are provided. You can accurately read large phase shifts from the parallax-free vector graticule. A precision calibrated phase shifter with a range of 30°, spread over 30 inches of dial length, is provided for measuring small phase shifts.

Dual Vector Display

In dual-channel operation, successive samples of channels A and B are displayed on a time-shared basis. The switching rate is locked to horizontal sync, and switching transients are blanked. You can conveniently compare input/output signals from video equipment on Channel A or B for phase and/or amplitude distortion.

The subcarrier processing channel contains two uncalibrated 0° to 360° phase-shifters and one 30° calibrated phase shifter. While viewing Channel A or B, you can switch either of the uncalibrated phase-shifters, AØ or BØ into the subcarrier processing channel. Each phase shifter locks to its respective channel when A and B channels are time-shared, permitting independent phase control of the Channel A and B displays. Unequal signal paths causing phase shifts are easily cancelled, leaving only phase and amplitude distortion caused by equipment deficiencies.

Video cable lengths may be accurately matched for time delay at color subcarrier frequency to less than 0.5° phase difference.

You can make accurate amplitude measurements of chrominance and luminance from the CRT display. Use the internal one volt luminance amplitude calibration test signal to check the gain accuracy of Channel A and B amplifiers and the luminance channel.

Time Base Displays

The linear time base operates at the line rate. Color signals may be demodulated along any desired axis, I, Q, and R-Y (for NTSC), and U, and V (for PAL and PAL-M), and displayed at the line rate on a linear time base.

Luminance-Color Separation

A luminance channel permits the separation and display of the luminance (Y) component from the composite color signal. You can also combine the Y component with the output of the chrominance demodulators for R, G, and B displays at a line rate. Amplitude measurements of color signal components can be made with an accuracy of 3%.

Vertical Interval Test Signal Observation

You can display VITS (Vertical Interval Test Signals) from front-panel selected lines of either field 1 or 2 on the 520A Vectorscope. For the 521A (PAL) and the 522A (PAL-M), you can display ITS from either fields 1 and 3 or fields 2 and 4.

Differential Gain and Differential Phase Measurements

The two main chrominance signal distortions — differential gain and differential phase — can be measured on the 520A (NTSC), 521A (PAL), and 522A (PAL-M) Vectorscopes. Differential gain (Figure 1) is a change in color subcarrier amplitude as a function of luminance level. In the reproduced color picture, saturation will be distorted in the areas between the light and dark portions of the scene. The 520A, 521A, and 522A permit differential gain measurements with accuracy to better than 1%.

Differential phase (Figure 2) is a phase modulation of the chrominance signal caused by changes in the luminance signal level. The hue will vary with scene brightness in the reproduced color picture. Differential gain and differential phase occur separately or together. You can read differential phase errors from the precision calibrated phase shift control or directly from the differential phase markings on the graticule.

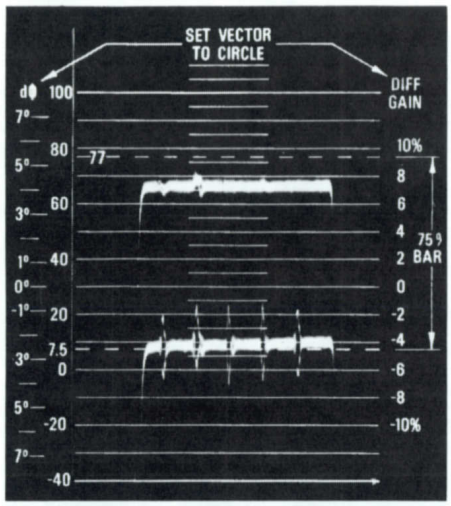
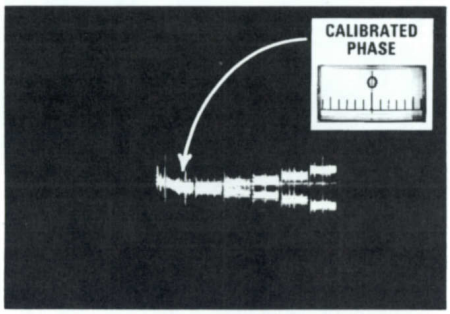


Figure 1. Differential Gain display from the 520A. Luminance is on in lower trace. On upper trace, luminance is off. Minor divisions of graticule indicate 1% differential gain. Double exposure.



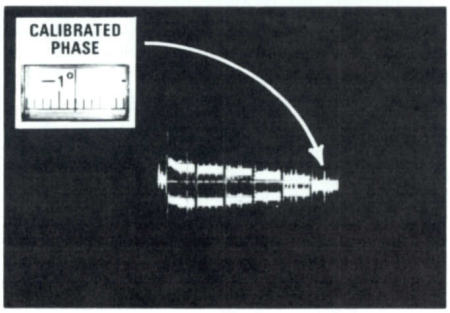


Figure 2. Differential Phase presentation from the 520A using a modulated staircase signal. Trace overlay technique provides excellent resolution for measuring small phase changes. The differential phase error from the reference point in top photo (first step of staircase signal overlayed) to point of measure in bottom photo (sixth step overlayed) is 1.2°.

CHARACTERISTICS

Graticule — Two separate graticules provide reference for vector and line sweep displays. The parallax-free vector graticule, or the luminance graticule, is automatically selected and edge-lighted concurrent with operating mode selection.

Z-Axis Input — The Z-Axis Input connector accepts external trace-brightening pulses for intensifying a portion of the display during the time of interest.

Video Inputs — Dual BNC input connectors for each channel permit 75 Ω loop-through operation with a return loss >46 dB to 5 MHz (exceeds CCIR recommendation 567, Part D and D.2). Amplitude range is 0.7 V to 1.4 V Video (sync tip to peak white).

AC POWER

Mains Voltage Range — 90 V ac to 136 V ac or 180 V ac to 272 V ac.

Mains Frequency — 47 Hz to 63 Hz.

As displayed on 520A

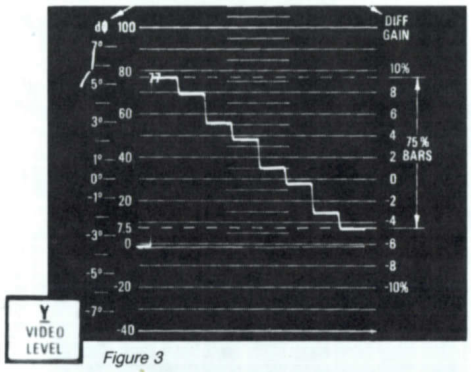


Figure 3

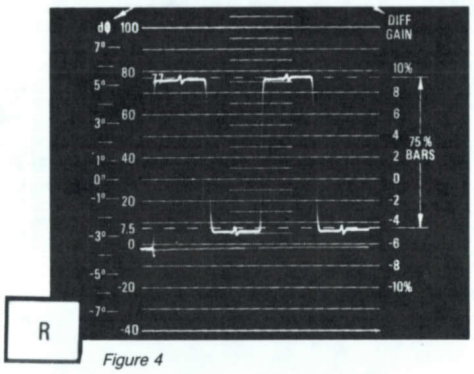


Figure 4

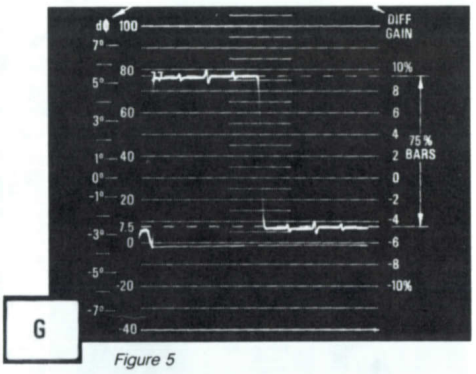


Figure 5

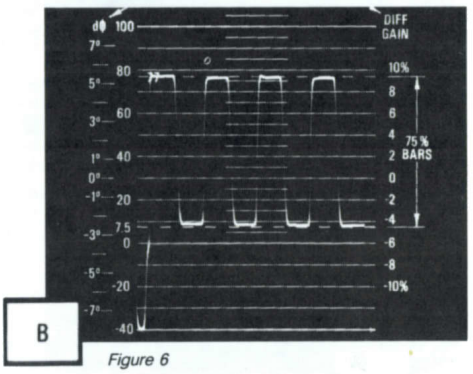


Figure 6

75% amplitude Color Bar Signal displayed on the line sweep graticule. Pushbuttons select line-sweep displays of luminance (Figure 3), decoded Red (Figure 4), decoded Green (Figure 5), and decoded Blue (Figure 6).

Power Consumption — 95 W maximum at 115 V ac/60 Hz. (Rear panel selector provides rapid accommodation to six line-voltage ranges. Factory set at 115 V ac for the 520A and 522A and 230 V ac for the 521A.)

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature Range — 0°C to +50°C ambient.

MECHANICAL CHARACTERISTICS

The vectorscopes are available in two mechanical configurations, a cabinet model and a rackmount model. These versions are electrically identical. The rackmount models fit in a 19 in rack and are provided with slide-out assemblies for convenient access to internal components.

PHYSICAL CHARACTERISTICS

Dimensions	Cabinet		Rackmount	
	mm	in	mm	in
Width	429	16.9	483	19.0
Height	178	7.0	178	7.0
Depth	487	19.2	483	19.8
Weights	**kg**	**lb**	**kg**	**lb**
Net	15.0	33.0	15.0	33.0
Shipping≈	27.7	61.0	27.7	61.0

INCLUDED ACCESSORIES

Smoke-gray filter, installed (378-0581-00); Rackmount: same as cabinet but includes rackmounting hardware, and slide-out assembly (351-0195-01); manual.

ORDERING INFORMATION

520A NTSC Vectorscope (Cabinet) **$7,750**
R520A NTSC Vectorscope (Rackmount) **$7,750**
521A PAL Vectorscope (Cabinet) **$8,050**
R521A PAL Vectorscope (Rackmount) . **$8,050**
522A PAL-M Vectorscope (Cabinet) ... **$8,670**
R522A PAL-M Vectorscope (Rackmount) **$8,670**

OPTIONAL ACCESSORIES

75 Ω Voltage Step-Up Termination — When used with a Tektronix vectorscope, the 75 Ω Voltage Step-up Termination provides an X5 increase in chrominance amplitude and lets you make more accurate Differential Gain and Differential Phase measurements. Input impedance to the termination is a constant 75 Ω. Use of the termination requires a source of external sync to the vectorscope.

Voltage Step-up Termination — For use with 520A (NTSC), 522A (PAL-M) Vectorscopes. Order 011-0100-01 ..... **$74**

Voltage Step-up Termination — For use with the 521A Vectorscope. Order 011-0109-00 ..... **$100**

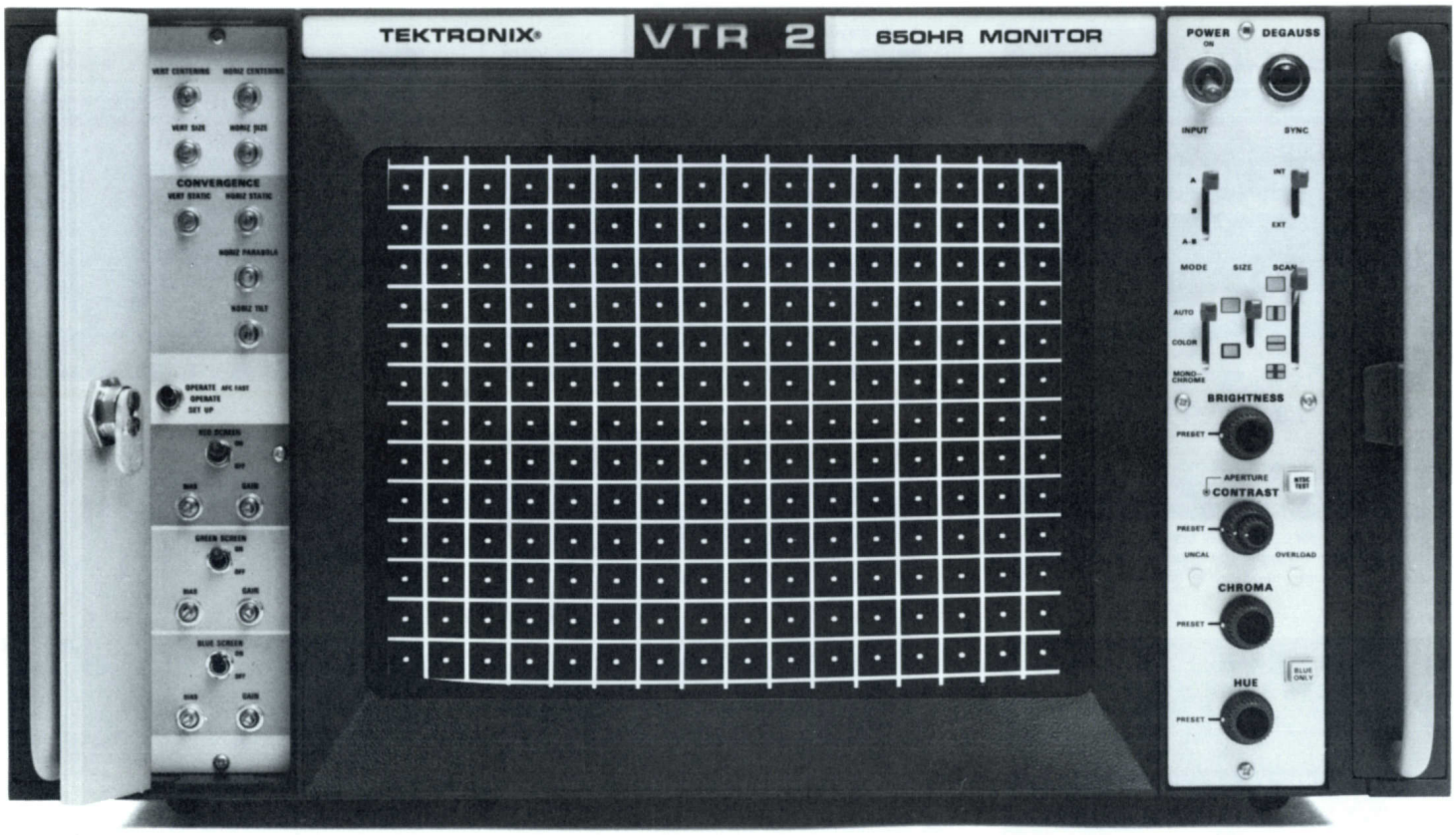
Single Sideband Chroma Amplitude Corrector — Designed for use with a Tektronix vectorscope in transmitter applications where a vestigial sideband signal is being demodulated with a detecting diode. The corrector provides an X2 increase in chrominance amplitude and passes luminance components with little or no attenuation. Input impedance is 75 Ω.

Chroma Amplitude Corrector — For use with 520A (NTSC), 522A (PAL-M) Vectorscopes. Order 011-0107-01 ..... **$84**

Chroma Amplitude Corrector — For use with 521A Vectorscope.
Order 011-0108-01 ..... **$111**

Recommended Camera — For display photographs: C-59AP with adaptor 016-0295-01. See camera section of this catalog for information.

R520A Cradle Assembly — For mounting the 520A in a WECO backless rack. Order 426-0667-00 ..... **$40**



650HR High Resolution Color Monitor

650HR

High Resolution Display Plus Capability for Critical Signal Analysis

0.25 mm Triad Pitch High Resolution Trinitron CRT

Variable Aperture Correction

Precise Color Tracking Over Full Signal Range

Two Video Inputs with Differential (A-B) Capability

Video Inputs Isolated from Ground for Hum Rejection

Capability for Front Panel Switching of External Sync Inputs

NTSC, PAL and Multistandard Decoders Available, RGB Input Optional

Precise Decoders with Outputs to Provide Vector Display on External X-Y Monitor

Unique Monochrome (White) Display of Decoded Blue Signal for Critical Analysis of Color Noise

The Tektronix 650HR Series color picture monitors are designed for exacting applications where picture quality and signal quality analysis are particularly important. The 650HR uses a Trinitron CRT with resolution capabilities which exceed the performance of encoded television signals. The decoders have sufficient chroma channel bandwidth to pass all of the information in standard signals.

The unique blue only mode feeds the decoded blue video signal to the red, green, and blue channels simultaneously. This produces a monochrome display with a high subjective sensitivity to chroma noise, allowing better analysis of video quality.

The chrominance channel may be manually switched to either the monochrome or color modes, or activated automatically by the presence of burst.

Circuits in the Tektronix 650HR Series are designed for color stability and consistency. Outputs are provided from the precision decoders and may be used to drive an X-Y monitor for a vector display. The regulated EHT supply is not affected by extreme changes in APL even when calibrated brightness, at peak white, is set at 30 fL. Raster size is held within 1%, while excellent clamping maintains a stable black level with a 0% to 100% range of APL.

In 650HR Series color monitors, you can shift the picture either horizontally or vertically, or both (pulse cross). This lets you monitor sync, burst, blanking, vertical interval test, and reference signals. When the monitor is operating in any of these display modes, brightness is automatically advanced to permit observation of the sync pulses and burst. Expansion of the vertical scan is provided in the pulse cross and vertical delay modes, so you can view individual lines in the vertical blanking inteval.

The 650HR Series monitors can be used in rack installations or separately in their own cabinets. They are compact, requiring only 276 mm (10.5 in) vertically. Versions are available for NTSC and PAL systems. Dual standard and RGB input versions are also available.

CHARACTERISTICS

Input Signal Level — 0.5 V p-p minimum composite video 2 V p-p maximum. (Exceeds CCIR recommendations 567, Part D and D.2.)

Impedance — Unterminated: High Z bridging inputs loop-through compensated for 75 Ω (not internally terminated). Return Loss: ⩾46 dB to 5 MHz, power on or off, input in use or not.

Maximum Safe Input — Exceeds CCIR Recommendation 451-2 (±5 V peak).

Hum Rejection — Hum is ⩾50 dB down when 4 V maximum RMS common mode mains hum signal is applied to the monitor in floating ground mode.

NTSC Luminance Channel — Bandwidth (notch filter removed) ≈6 MHz. Subcarrier notch filter automatically removed when burst is not present and Mode switch is in Auto position. Subcarrier notch filter removed when Mode switch is in Monochrome position. Dc Restoration back porch type; not affected by burst. Mains hum reduction due to dc restorer is <6 dB. Amplitude Linearity: Within 2%.

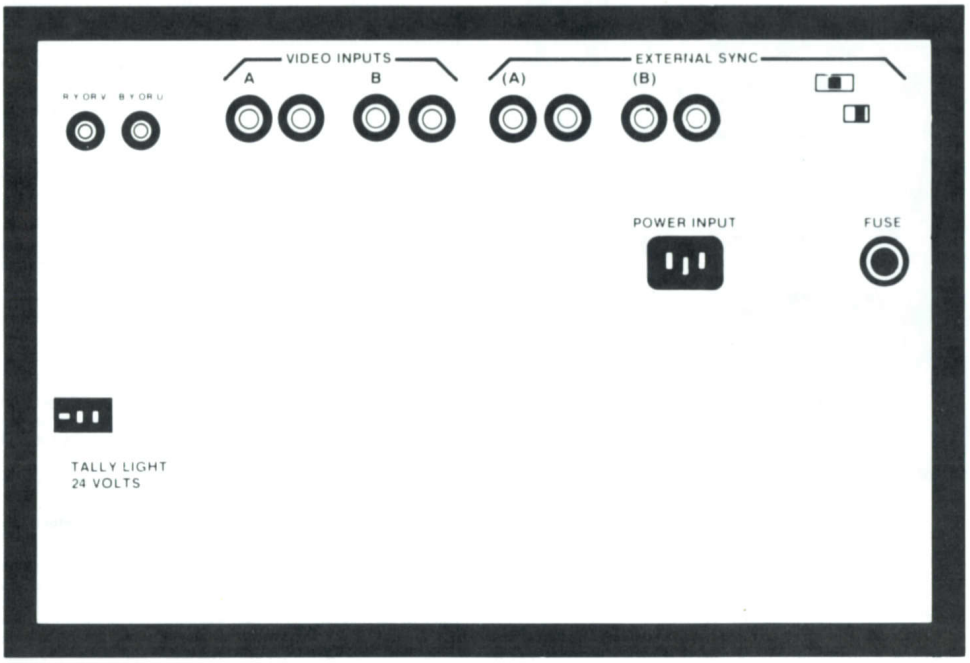
NTSC Chrominance Channel — Demodulation Axis: R-Y, B-Y. Bandpass: 1.3 MHz equiband. Gain Range: Preset at 0 dB; adjustable from −6 dB to +10 dB.

PAL Luminance Channel — Bandwidth (notch filter removed) ≈6 MHz. Subcarrier notch filter can be removed by changing internal jumper. Subcarrier notch filter normally left in circuit.

PAL Chrominance Channel — Demodulation Axis: U, V. Bandpass: ≈1.2 MHz. Gain Range: Preset at 0 dB; adjustable from −6 dB to +10 dB.

Residual Subcarrier Detection (On Applied Signal) — Color of displayed picture will shift due to any residual subcarrier. This feature can be inhibited by a jumper on the decoder board.

Chrominance/Luminance — Time Error: <30 ns. Gain Error: <3%.



Rear Panel

Delay — Red to green to blue <50 ns.

Subcarrier Regeneration — Phase Error: Within 1° with input burst variation of ±10 Hz from subcarrier nominal burst frequency. With Temperature Variation: Within 5° with ambient temperature variation from 0°C to +50°C; with 1° for any +10°C increment within the range 0°C to +50°C. With Input Signal Variation: Within 1° with input signal variations of ±3 dB from 1.0 V, within 3° with variation of burst/sync ratio of −6 dB to +10 dB. Breezeway Stability: ≤0.2° for burst timing errors including burst width variance (8 to 11 cycles), and breezeway variance ±0.28 μs. Phase Error Due to Noise: Within 1° with RMS white noise at −24 dB (0 dB = 700 mV RMS).

PICTURE

Height — 184 mm (7.2 in).

Width — 244 mm (9.6 in).

Underscan — ≈20% reduction in both height and width.

Aspect Ratio — 4:3.

Deflection Linearity — Vertical and Horizontal: 1% of picture height within a central area bounded by a circle whose diameter equals picture height, ±2% of picture height outside of central area.

Convergence Error — <1 mm within the central area. Outside of the central area, color separation (misconvergence) is <2 mm.

Unblanking — All active picture elements are displayed. (Horizontal retrace is accomplished within 10 μs.)

Color Temperature — 6500°k. Easily adjustable to other standards.

Calibrated Contrast — 30 fL at peak white of standard 1 V signal.

Calibrated Brightness — Displayed black may be preset to a level appropriate for ambient conditions.

EHT (Extremely High Tension) — 19 kV nominal, regulated. Load variations cause <1% picture size variation. Monitor complies, as of date of manufacture, with applicable DHHS standards under Radiation Control for Health and Safety Act of 1968.

Kinescope Protection — Failure of horizontal or vertical scanning shuts off the EHT. Failure of HV Regulator circuit does not cause EHT to soar excessively. EHT supply is current limited.

Heater Voltage — Regulated dc.

SYNC and TIMING

Signal Range — Composite sync 0.5 V p-p to 8 V p-p or composite video 0.5 V p-p to 2 V p-p.

Impedance — Unterminated: High Z bridging inputs loop-through compensated for 75 Ω (not internally terminated). Terminated: 75 Ω. Return Loss: ≥46 dB to 5 MHz with respect to 75 Ω.

Synchronization — Stable subcarrier regeneration, limited by line sync performance. Line sync white noise immunity is 20 dB. Field sync white noise immunity is 20 dB. Field sync stable with tilt equal to 100% of sync amplitude in vertical blanking. Stable with 20 IRE mains hum.

AFC (Two Loop AFC Type) — Phase Corrector: Corrects for phase errors due to side pincushion correction and other effects within the monitor. Slow AFC: Displays timing errors of incoming sync, particularly, 60 Hz or 240 Hz timing errors. Bandwidth is ≈25 Hz. Fast AFC: Largely corrects for incoming sync errors, ≈2 kHz bandwidth.

Scan Delay — Horizontal Delay: ≈1/4 line; displays burst. Vertical Delay: Displays the vertical blanking interval of the input signal expanded ≈2.5 times unless underscan is activated. If the underscan button is depressed, vertical expand is inhibited.

AC POWER

Mains Voltage Range — 115 V: Within 10% (104 V ac to 126 V ac). 230 V: Within 10% (207 V ac to 250 V ac maximum). 650HR, 650HR-1 are factory set for 115 V. 651HR, 651HR-1, 655HR, 652HR and 652HR-1 are factory set for 230 V.

Crest Factor — ≥1.3.

Mains Current — 1.5 A RMS maximum at 115 V, 60 Hz. 0.75 A maximum at 230 V, 50 Hz. Current is substantially higher during degaussing.

Degaussing Surge Current — 5 A RMS.

Power Consumption — 150 W maximum, 110 W typical.

Mains Frequency — 48 Hz to 66 Hz.

ENVIRONMENTAL CHARACTERISTICS

Temperature Range — Operating: 0°C to +50°C. Nonoperating: −40°C to +65°C.

Altitude Range — Operating: to 4.5 km (15,000 ft). Nonoperating: to 15 km (50,000 ft).

Shock — To 30 g's, 1/2 sine, 11 ms duration.

PHYSICAL CHARACTERISTICS

Dimensions	Cabinet		Rackmount	
	mm	in	mm	in
Width	426	16.8	483	19.0
Height	279	11.0	266	10.5
Depth	419	16.5	464*1	18.3*1
Weights	**kg**	**lb**	**kg**	**lb**
Net	22.7	50.0	23.5	52.0
Domestic Shipping	28.5	65.0	30.4	67.0
Export Shipping	36.3	80.0	37.2	82.0

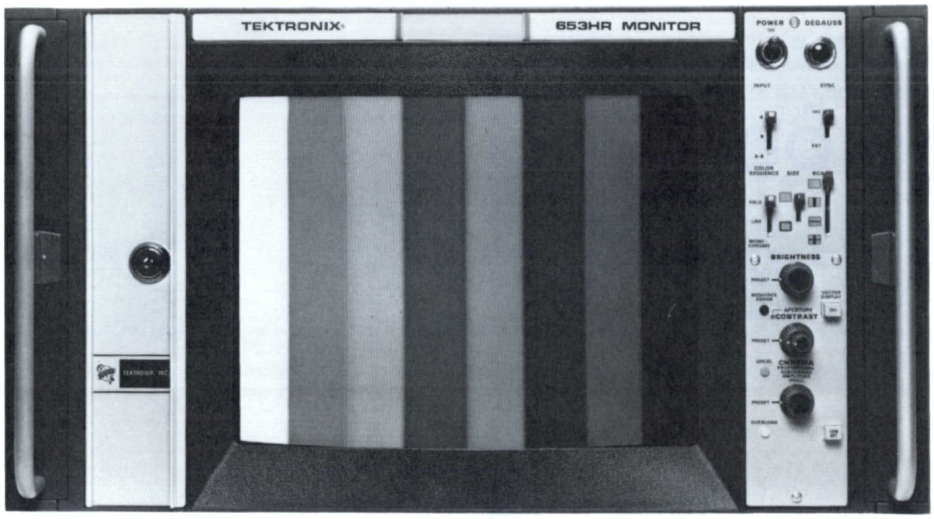
*1 *With handles*

ORDERING INFORMATION

All 650HR Monitors are shipped with rackmounting hardware. Cabinet version hardware is also included.

MODEL NUMBER	NTSC	PAL	RGB	PRICE
650HR	•			$5,760
650HR-1	•		•	$5,970
651HR		•		$6,010
651HR-1		•	•	$6,250
652HR		M		$6,430
652HR-1		M	•	$6,660
655HR	•	•		$6,660
655HR-1	•	•	•	$6,925

For Vector Display with NTSC, PAL or NTSC + PAL Monitors Order Type 1424 Display Unit $1,995



653HR Color Picture Monitor

653HR

Color Sequencing from Field Identification Signals or Line Burst

Precision Decoding Allows Use of R-Y, B-Y Outputs for Vector Display Measurements

RGB Inputs with Vector Display Outputs (Optional)

PAL/SECAM Version Available (656HR) with Front Panel Control of Decoding Standard

Variable Aperture Correction

Vertical and Horizontal Delay Display Modes

Reduced Chrominance Line Crawl

Indicates Color Sequence Error

Rapid Retrace — Entire Picture Area is Displayed in Reduced Scan

Two Switchable Inputs Isolated From Ground for Hum Rejection

Tektronix SECAM color picture monitors are identical to the 650HR Series except they are specially designed for use on SECAM systems. They are available in versions for SECAM (653HR), SECAM + RGB (653HR-1), SECAM/PAL (656HR) and SECAM/PAL + RGB (656HR-1).

All monitors provide unique measurement possibilities and are designed for exacting applications. For example, with an auxiliary vector display, encoding tolerances (including white reference quality) are displayed for both 75% and 25% amplitude color bars. You can observe encoder-limiting action on field identification signals and encoder transient behavior.

Color sequencing is front panel controlled by a three position mode switch. In the Field mode, field identification signals are used for color sequencing and a color display is enabled by the presence of detectable field identification signals. In the Line mode, line burst determines color sequence, and a color display is enabled whenever detectable SECAM subcarrier is present. Use of the Monochrome mode blanks the chrominance channel.

In the internally selectable Forced-Color mode, the very high limiting ratio of the chrominance channel lets you use the Tektronix 653HR Series monitors to search for very small amounts of crosstalk or other unwanted signals. By displaying the chrominance portion of such signals on a brightened display, you can easily identify the source.

Two PROMs (Programmable Read Only Memories) are used in the Tektronix 653HR Series monitors for generating accurate timing signals. Their use eliminates the need for many internal adjustments and possible drift related to the timing of internal signals. One of these PROMs is programmed with information corresponding to the lines containing subcarrier (including field identification lines) in 625/50 SECAM systems. The monitor then serves as a check on improper additions or deletions of lines that might possibly occur in improperly adjusted VTRs, processing amplifiers, and switchers.

Chrominance line crawl is greatly reduced by using separate acoustical delay lines; one for D'R and one for D'B. With front panel controls, you can turn off luminance or chrominance, and examine each one separately. Brightness is automatically advanced for easier viewing when luminance is turned off for examination of chrominance. For purity checks, you can set up the equivalent of a flat field display by switching luminance off in a monochrome mode (chrominance off).

The monitor's chroma control has two operating modes. When the control is in, the chrominance is independent of subcarrier amplitude. When the control is out, the chrominance is proportional to subcarrier amplitude. In the first mode, the saturation will vary with incoming video level. In the latter mode, correct saturation will be maintained for varying signal levels. In either mode, both a preset (detent) position and a variable range are available. Switching between the two modes in the preset position provides an indication of abnormal chrominance or luminance amplitude.

CHARACTERISTICS

SECAM PERFORMANCE-LUMINANCE CHANNEL

Bandpass Without Chrominance Trap — (Aperture Corrector set for 0 dB). Amplitude: ±0.5 dB to 5 MHz. Aperture Corrector Maximum Range: 8 dB; doubled peaked at 2.5 MHz and 7 MHz; ≤3 dB between 4.0 MHz and 5 MHz.

Chrominance Filter — Subcarrier Rejection: >25 dB at 4.250 and 4.406 MHz, <−1 dB at 5.5 MHz. NOTE: The chrominance filter is removed from the luminance channel whenever the display is monochrome.

Pulse Distortion — <1% tilt on 50 Hz squarewave. <0.5% tilt on 15 kHz squarewave.

Dc Restoration — Back porch type, not affected by burst. Mains hum reduction due to dc restorer is <6 dB.

Amplitude Linearity — Within 2%.

Luminance Off Facility — Displays chrominance only and automatically advances brightness.

SECAM PERFORMANCE-CHROMINANCE CHANNEL

High Frequency De-emphasis — Matching to Encoder High Frequency Pre-emphasis: Error ≤0.5 dB over the range 3.9 MHz to 4.75 MHz; <3 dB at 2.85.

Drift (Center Frequency) — Within ±20 kHz.

Luminance Rejection — >46 dB at 15 kHz.

Limiting Ratio — >60 dB.

Ultrasonic Delay Line Error — <30 ns.

Crosstalk at Input to Discriminators — Between Direct and Delayed Chrominance Signals: Alternate line crawl on display is minimized through the use of separate delay lines for the D'R and D'B chrominance signals.

Discriminator Linearity — Overall: Within ±1%. Incremental: Within 1%.

Demodulator Center Frequency — Clamped to crystal reference stabilized within ±0.250 kHz.

Chrominance Sequence and Color Enable — Chrominance sequence and enable are statistically averaged with hysteresis for best performance under poor signal-to-noise conditions. Field Mode: Based upon field identification signals. Chrominance Amplitude: Disable when chrominance is more than 12 dB low, may be internally selected. Line Mode: normally based upon line burst with no chrominance amplitude disable. An internal jumper provides chrominance amplitude disable if required.

Chrominance Unblanking — Programmed internally according to 625 line 50 Hz SECAM standards. Field identification signals are displayed in vertical scan delay modes.

Saturation — Selectable to treat subcarrier as FM signal or to vary the saturation with incoming chrominance level. Independent of Subcarrier Amplitude: Gain Error <3%. Dependent on Subcarrier Amplitude: Tracking error <5% for signals within ±3 dB to −6 dB of normal amplitude. Chroma Control Separately Adjustable: ±6 dB.

Cross Talk — Between R-Y and B-Y >40 dB attenuation.

Chrominance/Luminance Time Error — <60 ns with properly adjusted bell filter and low frequency de-emphasis.

Sequence Error Indicator — When the front panel red light indicates that the incoming SECAM signal has a chrominance sequence opposite to that indicated by an externally applied 7.8 kHz signal. Also when the monitor is used in the Line mode the light will indicate when the field identification signals are reversed with respect to the Chrominance Sequence present during the active picture.

VECTORSCOPE OUTPUTS

Calibrated Modes (Dots in Boxes) — Selected by front-panel control for either 75% color bars or 25% color bars (SECAM and RGB only). Vector locations are within ±2% of vector magnitude.

Vectorscope Drive Capability — Suitable to drive 10 ft of 75 Ω coaxial cable (unterminated) to X-Y display.

Required X-Y Display Deflection Sensitivity — 0.05 V/cm on both X and Y axis.

Required X-Y Display Input Resistance — ≥100 kΩ.

RGB Vector Display — R, G, and B input signals are matrixed to form R-Y and B-Y signals which are switched to the rear-panel vector output connectors when the RGB inputs are selected.

RGB Matrix Error — R-Y and B-Y relative output signal amplitudes are within ±2% of desired values when equal R, G, and B signals are supplied.

RGB Centering — Black level is clamped to within ±9 mV which corresponds to ±1 mm in the 75% vector display.

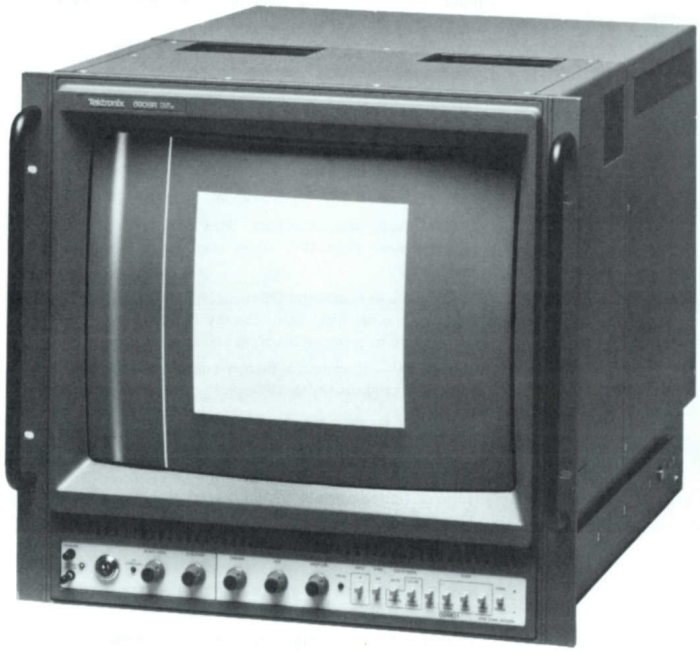
Other Inputs and Outputs — 7.8 kHz input, 7.8 kHz output, and field 1 pulse output.

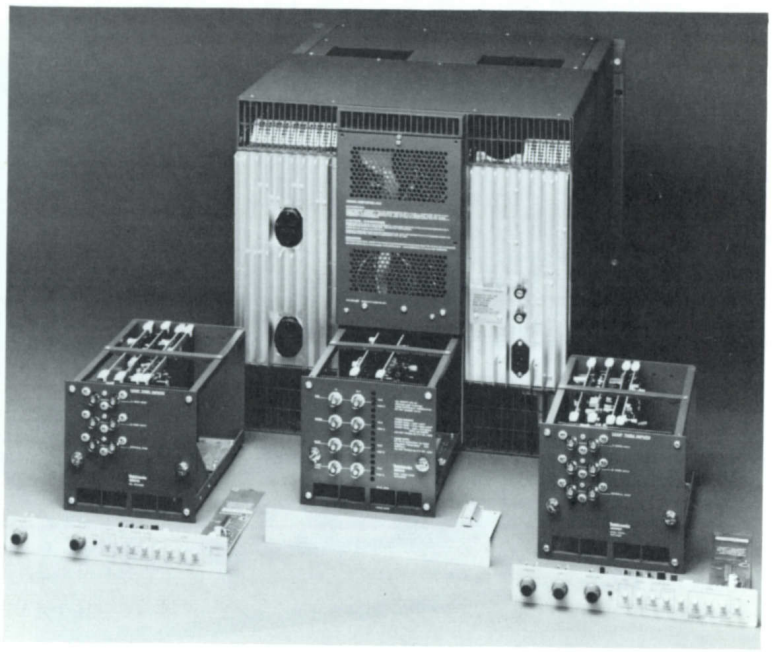
PHYSICAL CHARACTERISTICS

Same as 650HR on previous page.

ORDERING INFORMATION

653HR SECAM Monitor	**$7,040**
653HR-1 SECAM + RGB	**$7,280**
656HR SECAM + PAL	**$7,515**
656HR-1 SECAM + PAL + RGB	**$7,740**
Option 01 — MiniQuick Connectors	**+$200**





690SR Color Monitor

High-Resolution 19-Inch Dot-Shadowmask CRT

Precise Color Convergence

Stablized Color Balance

Rugged Modular Construction

Plug-in Interface (Decoder) Modules

Operates at Various Scan Frequencies

Adjustable Picture Size and Aspect Ratio

The 690SR is designed to meet critical needs for image evaluation and video signal quality control in television, high definition television, and computer imaging environments. The standard high resolution delta gun, dot-shadowmask CRT and precise, stable video processing circuits provide faithful rendition of picture details and ease of closeup viewing. Optional medium resolution CRTs provide more uniform screen appearance and tightly controlled phosphor colorimetry for those applications where greater viewing distance or signal limitations ease the requirement for the highest resolution display. A high resolution, long persistence phosphor CRT is also available if needed for flicker reduction in interlaced systems.

With any of these four CRTs, Tektronix' unique color convergence system provides accurate color registration over the entire screen (less than 0.5 mm maximum error, equivalent to less than 0.18% of picture height) so that fine details can be observed anywhere in the picture. Stabilization of the operating point of each gun in the CRT compensates for tube aging and helps to maintain accurate long term color balance without frequent maintenance.

A logical and noninteractive set of convergence controls makes reconvergence a quick and straight forward task. All controls are identified by color-coded patterns and produce a comfortable up-down or right-left motion on the screen with negligible interaction. Several function switches are also located within the front drawer in the television models (Options 02, and 11). In general, these switches permit the 690SR to be used either as an accurate picture/signal monitor to display faults if they are present, or as a high quality picture display monitor that provides a clean picture even in the presence of signal defects.

Front panel controls have detent positions so that the monitor may be returned to its preset condition quickly and accurately. Adjustments for the preset positions of front panel controls are located within the lockable front drawer together with virtually all other adjustments needed for routine setup.

Picture size can be adjusted from overscan to underscan without significant loss in convergence or linearity. This feature makes it possible to conduct experiments at various image sizes and aspect ratios or to set the monitor for different system characteristics by readjusting the size and position controls.

There are three versions of the 690SR monitor mainframe which differ in scanning capability. The standard (nonoption) 690SR is designed for operation with conventional broadcast television formats with horizontal scan frequencies near 15.7 kHz. The Option 48 mainframe can be calibrated at the factory for operation at any horizontal scan frequency in the range of 15.7 kHz to 37.4 kHz. The Option 40 mainframe can be calibrated to any rate within the range and also is guaranteed to meet all specs after field recalibration at a different rate.

White balance is adjustable to standard D6500 or to other desired standards using controls located in the front drawer. A Setup switch allows the raster height to be reduced to facilitate low-level-light adjustments. Additional features in the television models include horizontal and vertical scan delays, and pulse cross. The CRT is automatically brightened in these modes to facilitate evaluation of blanking interval detail.

The 690SR mainframe is essentially an RGB monitor. The signal conditioning and/or decoding functions are performed in plug-in modular units. The 69M41 provides RGB input, with provision for external sync. The 69M01 is an NTSC decoder with a one line comb, and the 69M10 decodes PAL signals. The front control panel for each of these interface modules is also modular and is fitted into the control drawer of the mainframe. (A blank panel is provided with the 69M41 since no controls are needed for the RGB interface.)

All 690SR color monitors are fully enclosed and may be mounted in a standard relay rack. The 690SR complies with UL478 and UL1244, CSA Bulletin 556B, IEC348, and IEC435. The 690SR also complies, as of date of manufacture, with applicable DHHS standards under Radiation Control for Health and Safety Act of 1968 and with FCC/CBEMA standards for electromagnetic-interface control.

Various combinations of interface, CRT, and scan capability are orderable. The following "system" options allow convenient specification of common configurations.

690SR OPTION 02

The 690SR Option 02 is a NTSC color monitor system that consists of a comb/notch filter/decoder module (69M01 Comb Decoder) installed in a 690SR Mainframe.

690SR OPTION 11

The 690SR Option 11 is a PAL color monitor system that consists of a notch filter/decoder module (69M10 PAL Decoder) installed in a 690SR Option 27 Mainframe. The picture tube has controlled phosphor chromaticity values in accordance with EBU recommendations.

690SR OPTION 42

The 690SR Option 42 is a RGB color monitor system which is suitable for television and non-television color graphics or imaging applications. This system consists of a RGB module (69M41 RGB/Comp Sync Interface) installed in a 690SR Option 40 mainframe. Flexible scan rate circuitry allows the system to be calibrated for a horizontal scan rate from 15 kHz to 37.5 kHz and be used with either interlaced or noninterlaced fields. (The Option 42 is factory-calibrated to operate at a horizontal scan rate of 31.5 kHz.) With these scan rates, the monitor displays from 240 to 600+ lines, noninterlaced at a 60 Hz frame rate; or from 480 to 1200+ lines, 2:1 interlaced at a 30 Hz frame rate.

TV INTERFACE CHARACTERISTICS

(Option 02, 69M01; Option 11, 69M10 as noted.)

VIDEO INPUT

Amplitude — 0.5 V to 2.0 V p-p composite video.

Connector Type — BNC.

Return Loss — 46 dB minimum to 5 MHz loop-through compensated for 75 Ω (not internally terminated).

Common-Mode Hum Rejection — 50 dB minimum (with 4 V RMS mains hum applied to the shield and center conductor).

LUMINANCE CHANNEL

Amplitude Linearity — Within 2%.

Bandwidth — (Measured with aperture corrector off).
Option 02: 15 kHz to 10 MHz (with the chrominance filter removed).
Option 11: Flat within ±1 dB from 15 kHz to 8 MHz and ±1.5 dB from 8 MHz to 12 MHz with the response at 15 kHz as the reference.

Note: The chrominance filter is automatically removed when Mode switch is in Auto position and burst is not present or when Mode switch is in Manual and Color Monochrome switch is in Monochrome.

Aperture Corrector Range — ≈6 dB boost available at 3.5 MHz or 7 MHz depending upon an internal jumper position.

Chrominance Rejection — ≥20 dB at fsc.

Dc Restoration — Back porch negligibly affected by normal burst amplitudes.

CHROMINANCE CHANNEL

Demodulation Axis
Option 02 (NTSC): R-Y, B-Y.
Option 11 (PAL): V and U.

Bandwidth
Option 02 (NTSC Comb): 3 dB down at 0.6 MHz and 10 dB down at 1.0 MHz.
Option 11 (PAL): Simple Decoding is ±1.3 MHz from fsc to −3 dB response; Deluxe Decoding is ±0.8 MHz from fsc to −3 dB response.

Gain Range — −6 dB to +10 dB (preset at 0 dB).

Chrominance/Luminance Timing Error — 50 ns maximum.

Residual Subcarrier Detection — Three-position switch selects to display or not display color shift due to residual subcarrier; the third switch position causes color to shift at a 2 Hz rate for enhanced visibility when residual subcarrier is present.

Blue Only — Selectable from the front panel. (When activated, all three output amplifiers are driven with the blue signal resulting in a monochrome display. This enhances noise visibility and is useful for checking and adjusting chroma and hue controls using SMPTE Bar test signals.

Color Bar Decoding Error — ±3%.

Display Modes
Options 02 (NTSC): Auto, Color, and Monochrome.
Option 11 (PAL): Auto, Color (PAL Deluxe and PAL simple), and Monochrome.

SYNC AND TIMING

Stable subcarrier regeneration limited by line-sync performance; field sync stable with tilt = to 100% of sync amplitude in vertical blanking; field stable with 20 IRE mains hum for Option 02, and 143 mV of mains hum for Option 11.

Modes — Internal or external sync, selectable from the front panel.

Input — 0.5 V to 2 V p-p composite video or 0.2 V to 8 V p-p composite sync.

Return Loss — 46 dB minimum to 5 MHz; Loop-through compensated for 75 Ω (not internally terminated).

Line and Field Sync White Noise Immunity — 26 dB.

Horizontal Jitter — Typically 50 ns or less (Slow AFC Mode) with 1 RMS V of voltage mains hum, variable APL 10% to 90%, and −26 dB white noise.

Vertical Jitter — 1 μs p-p maximum; typically ≤100 ns.

AFC — Switchable Slow/Fast; Slow AFC displays errors of incoming sync; Fast AFC largely corrects for incoming sync timing errors.

Scan Delay — Horizontal Delay: ≈one-third line time. Vertical Delay: ≈one-half field time. Display is intensified in delayed scan modes to enhance blanking and sync details.

Underscan — Switchable; factory-set to reduce size by 10%; adjustable range ≈1% to 15%.

RGB INTERFACE CHARACTERISTICS

(690SR Option 42, 69M41)

RGB VIDEO INPUTS

Nominal Noncomposite Signal (External Sync Required) — 0 V low light (black); 0.7 V high light for each RGB channel.

Nominal Composite Signal (Internal Sync) — 0 V low light (black); 0.7 V high light; −0.3 V sync. Sync may be present on each RGB channel, but internal sync is taken only from green channel.

Maximum Allowable Signal Range — Equivalent to the nominal levels ±6 dB (0.5 to 2X nominal p-p signal levels).

Connector Type (BNC) — Input Impedance: 75 Ω ±1% loop through or switch selectable internal termination; >15 kΩ unterminated.

Return Loss — 30 dB from 50 kHz to 25 MHz; 27 dB from 25 MHz to 50 MHz.

Ac Coupled — <1% line-time tilt for a 64 μs line.

Back Porch Clamp Timing — Clamp is active from a minimum of 0.54 μs to a maximum of 1.44 μs after the trailing edge of sync; vertical serrations must be at least 1.44 μs wide, if used.

Pulse Response — (10% to 90%) ≤5.5 ns risetime or falltime.

SYNC AND TIMING

Input — Internal and external sync; jumper selectable.

External Sync Operating Input Range — 100 mV to 8 V p-p adjustment range with composite sync applied to Comp Sync input connector. 400 mV to 8 V p-p adjustment range with composite video applied to Comp Sync input connector.

Internal Sync Operating Input Range — 400 mV to 2 V p-p adjustment range with composite video applied to Green input connector.

Connector Type (BNC) — Input Impedance: 75 Ω ±1% terminated loop through or switch selectable internal termination; >15 Ω unterminated.

Return Loss — 30 dB from 50 kHz to 10 MHz.

Coupling — Ac coupled and dc restored at sync tip.

Sync Polarity — Jumper selectable.

Horizontal Timing — RS-170, RS-330 or RS-343A sync; vertical serrated pulses and/or equalizers may be omitted; front porch not required (Block Sync).

Horizontal Rates (AFC) — 15 kHz to 38 kHz.

Random Sync Jitter (p-p) — <0.2% of horizontal period.

Lock-in Range — ±500 Hz without adjustment.

Horizontal Position Adjustment Range — >±12% of horizontal period.

Vertical Rates — 43 Hz to 90 Hz.

Vertical Sync Pulse Required — >60 μs; <240 μs.

Vertical Sync Random Jitter — 0.2 μs p-p.

690 COLOR CRT SCREEN CHARACTERISTICS AND OPTIONS AVAILABLE

	Dot Pitch	Phosphor Screen	Red X	Red Y	Green X	Green Y	Blue X	Blue Y	Application Information
Standard Product	0.31 mm	Nominal	0.610	0.340	0.280	0.590	0.152	0.063	Optimized for highest resolution and good brightness
		Tolerance	±0.02		±0.02		±0.02		
		Persistance	Medium Persistance						
Option 25 Television Display (US)	0.43 mm	Nominal	0.630	0.340	0.310	0.595	0.155	0.070	Optimized for good white field uniformity and tight chromaticity tolerance
		Tolerance	±0.005		±0.005		±0.005		
		Persistance	Medium Persistance						
Option 26 Computer Display (Interlaced)	0.31 mm	Nominal	0.620	0.330	0.210	0.675	0.150	0.060	Optimized for computer displays with low refresh rates and good resolution Less brightness than standard product Antiglare face plate
		Tolerance	±0.02		±0.02		±0.02		
		Persistance	0.6 ms (to 10%)		16 ms		0.02 ms		
Option 27 Television Display (EBU)	0.43 mm	Nominal	0.640	0.330	0.290	0.600	0.150	0.060	Optimized for good white field uniformity Tight chromaticity tolerance centered upon EBU spec
		Tolerance	±0.005		±0.005		±0.005		
		Persistance	Medium Persistance						

Note: X, Y values are based upon 1931 CIE system

MAINFRAME CHARACTERISTICS

PICTURE

CRT Size — 19 in diagonal (nominal).

Height — 279 mm (11 in).

Width — 373 mm (14.7 in).

Aspect Ratio — 4:3.

Phosphor Dot Triad Spacing — 0.31 mm (standard); (see CRT options for other triad spacing).

Convergence Error — Maximum misconvergence 0.5 mm anywhere on the screen.

Geometric Distortion — ±1% within a circle bounded by screen height; ±1.5% anywhere else.

Incremental Linearity Error — ±1.8 mm (±0.07 in) over a nominal 25.4 mm (1 in) distance anywhere on the screen.

White Colorimetry — Factory-adjusted to Standard D6500; may be adjusted to other standards.

Contrast (Light Output) —
Standard or Option 25 CRT: Highlight preset range 10 to 50 fL, maximum control range 6 to 62 fL.
Option 11 or Option 27 CRT (EBU): Highlight preset range 9 to 45 fL, maximum control range 5 to 55 fL.
Option 26 CRT (Long Persistance): Highlight preset range 9 to 23 fL, maximum control range 5 to 23 fL.

Gamma — Determined by CRT (≈2.3).

CRT Protect — Failure of horizontal or vertical scan will turn off CRT high voltage supply.

Blanking — Vertical: ≤600 μs. Horizontal: <6.75 μs.

POWER REQUIREMENTS

Input Voltage Ranges — 103 V ac to 127 V ac or 207 V ac to 250 V ac.

Frequency Range — 48 Hz to 66 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	444	17.5
Depth	579	22.8
Weights ≈	**kg**	**lb**
Net	49.9	110
Domestic Shipping	72.6	160

Rackmounting Information — Rear surface of monitor 559 mm (22 in) behind rackmounting surface, 690SR with interface module installed.

ENVIRONMENTAL

Operating Temperature — 0°C to +50°C.

Nonoperating Temperature — −55°C to +75°C.

Relative Humidity — Operating: To 90% at +30°C (derated by 0.75% for each degree above +30°C). Nonoperating: to 90% at +60°C.

Altitude — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

INCLUDED ACCESSORIES

8 ft power cord (161-0104-00); slide-out tracks w/mounting hardware (351-0395-00); two front drawer keys (214-3292-00); manual.

ORDERING INFORMATION

690SR Color Monitor, (High Resolution (0.31 mm Triad Pitch) CRT **$6,300**

Option 48 — Single Rate Calibration Capability ..... **NC**

Option 40 — Multirate Calibration Capability ..... **+$850**

Option 20 — Delete Rack Slides and Front Handles . **−$150**

CRT OPTIONS

Option 25 — Controlled Phosphor Colorimetry, Medium Resolution (0.43 mm Triad Pitch) CRT ..... **−$250**

Option 26 — Long Persistence Phosphor, High Resolution (0.31 mm Triad Pitch) CRT ..... **+$150**

Option 27 — EBU Phosphor Colorimetry, Medium Resolution (0.43 mm Triad Pitch) CRT ..... **−$150**

INTERFACE MODULES

69M01 NTSC Comb Decoder **$850**

69M10 PAL Decoder **$850**

69M41 RGB Interface **$510**

SYSTEM OPTIONS

Option 02 — Standard Mainframe with 69M01 Installed ..... **+$765**

Option 11 — EBU CRT (Option 27) Mainframe with 69M10 Installed ..... **+$650**

Option 42 — Multirate (Option 40) Mainframe with 69M41 Installed ..... **+$1,360**

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal European 220 V/16 A, 50 Hz

Option A2 — UK 240 V/15 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 250 V/10 A, 50 Hz

OPTIONAL ACCESSORIES

Rigid Module Extender — For circuit modules.
Order 067-0999-00 ..... **$50**

Minimum Load Unit — For power supply.
Order 067-0998-00 ..... **$175**

Flexible Extender — For interface modules/decoders.
Order 067-1000-00 ..... **$125**

Linearity Graticule — 11 x 15 lines.
Order 067-1034-00 ..... **$150**

Linearity Graticule (NTSC) 14 x 17 lines.
Order 067-1054-00 ..... **$150**

Linearity Graticule (PAL) — 15 x 20 lines.
Order 067-1055-00 ..... **$150**

See this color product in the reference section beginning on page 9.

NTSC SIGNAL GENERATOR SELECTION GUIDE

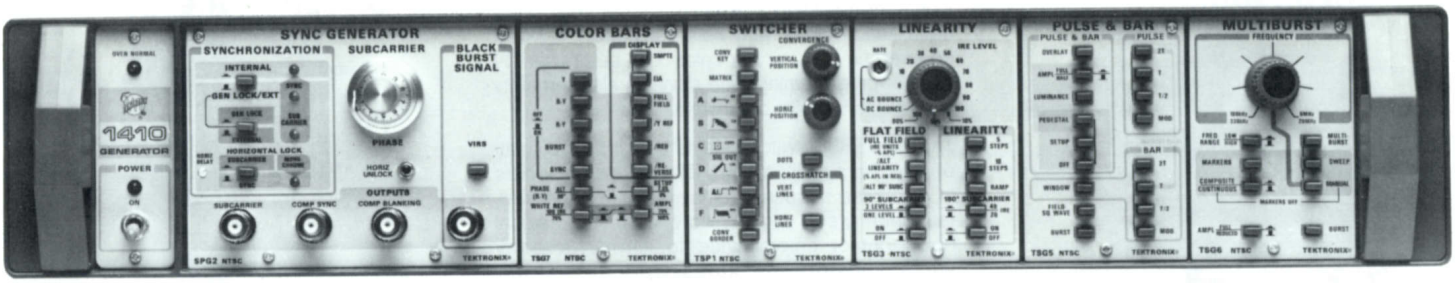
The following guide will help you select the proper NTSC generator to meet your needs. We recommend that you contact your nearest Tek sales engineer for further assistance.

		1410 SERIES							
	1910	TSG7	TSP1 TSG2	TSG3	TSG5	TSG6	SPG2	1470	147A
VIRS	••						*4		VITS ONLY
Full Field Color Bars	••	•						•	
EIA Color Bars	•	•							
SMPTE Color Bars	•	•							
Color Bars/Y Reference	•	•							
Color Bars/Red Reference	•	•							
Color Bars/Reverse		•							
Luminance Ramp 100 IRE	••								
Red Field	••							•	
Blue Field								•	
Green Field								•	
Modulated 5-Step Staircase	••			•				•	••
Modulated 10-Step Staircase	••			•					••
Modulated Ramp 100 IRE	••			•					*5
Modulated Ramp 80 IRE	••								
Modulated Pedestal	••			•					
NTC7 Combination	••								
Composite Test Signal NTC7	••								••
FCC Composite	••								*6
Convergence Signal	•		•					•	
Black Burst	••						•	•	
Full/Reduced Amplitude Multiburst	••					•		*3	••
Frequency Sweep						•			
Sin^2 Pulse and Bar					•				••
Sin^2 Pulse and Window					•			*1	•
Modulated Pulse and Modulated Bar	••				•				
Field Square Wave	•				•				•
Noise Measuring Capability									••
Flat Field/Variable Level	*2			•					•
APL Bounce (AC)	•			•					•
APL Bounce (DC)				•					
Test Signal/Variable APL	• *7			•					•
Multipulse 70 IRE	••								
Multipulse 100 IRE	••								
Color Multipulse	••								
Sin X/X	••								
Special Multipulse	••								
MATRIX (PROGRAMMABLE)	THREE								
Digital Signal Generation	•								
Ext VIT Input	Four								ONE
Digital Input/Output	••								
RS232 Programmability	•								
RS170A Standard Output	•	•	•	•	•	•	•		

A few signals may require reprogramming and some signals may not be available simultaneously.

Test Signals:

*¹ Window only.
*² 0,10,25,50,100 IRE
*³ Reduced only.
*⁴ As a line 19 signal on the Black Burst output.
*⁵ 90 IRE Ramp.
*⁶ Specify 147A Opt 01.
*⁷ High or Low
• Full-Field Signal.
•• Full-Field Signal, also available as VITS.



1410R Option 04 Test Signal Generator

1410 NTSC/1411 PAL/1412 PAL-M

Five Test Signal Generators and One Switcher

Conforms to EIA Standard RS-170A (1410)

Sync to Subcarrier Phasing Maintained or Corrected

Color Frame Reference Output

Genlock to Composite Video

Lock to External References

Adjustable Blanking Widths

Adjustable Sync Delays (H and V)

Broadcast Quality

The 1410 Series Sync and Test Signal Generators are precision generators for use in studios, remote vans, maintenance facilities and anywhere high quality sync or test signals are required.

Three different models are available. The 1410 is for NTSC applications, the 1411 for PAL and the 1412 is for PAL-M applications.

Each 1410 Series generator includes a genlock sync pulse generator. Five different test signal generators (four for PAL-M) and one signal switcher are available for each color standard (NTSC, PAL, PAL-M). Any combination of up to five test signal generators and signal switchers can be installed in one mainframe. The following components are available for each color standard.

1410 SERIES PRODUCTS

	Color Standard		
Description	NTSC	PAL	PAL-M
Mainframe	1410	1411	1412
Sync Pulse Generator	SPG2	SPG12	SPG22
Color Bars Generator	TSG7	TSG11	TSG21
Convergence Generator	TSG2	TSG12	
Linearity Generator	TSG3	TSG13	TSG23
Pulse & Bar Generator	TSG5	TSG15	TSG25
Multiburst Generator	TSG6	TSG16	TSG26
Signal Switcher	TSP1	TSP11	TSP21

The 1410 Series generators may be ordered with standard combinations of signal generators or they can be configured to your specific requirement. A 1410 Series generator can be ordered with a minimal complement of signal generators now and others added later as your needs grow.

1410 Series test signal generators begin on page 190. If further assistance is needed contact your local Tektronix Television Sales Engineer.

Unless otherwise indicated by a statement enclosed by parentheses ( ), all information characteristics and descriptions of the 1410 NTSC Series and its generators applies equally to equivalent mainframes or generators for the 1411 PAL and 1412 PAL-M Series. Information in parentheses applies only to the specified series.

SYNC PULSE GENERATORS

The SPG2, SPG12 and SPG22 are high quality sync generators designed for use in systems where accuracy, stable SCH (sync-to-subcarrier) phasing capability, and lockup mode versatility are of prime importance.

Two external synchronization modes, external reference and genlock, are available. In the genlock mode, line field, subcarrier, and PAL pulse (SPG12, SPG22) timing are derived from the incoming composite video signal.

In the external reference mode, line, field, subcarrier, and PAL pulse timing is derived from individual reference signals applied to the generator.

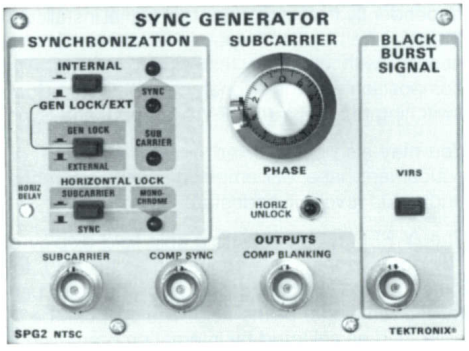
The SCH phasing can be set or maintained at any offset. This is made possible by locking the generator color subcarrier to the reference color subcarrier and referencing generator-line and field-sync-signal timing to subcarrier rather than line and field sync on the incoming reference signals. This feature is of value in editing and program assembly applications. A color frame identification pulse output identifies field 1 of the color field sequence. Should the user desire, the SCH phasing feature of the sync pulse generator can be disabled with a front panel control. In this mode of operation the SCH phasing of the incoming signal is maintained by locking subcarrier to incoming burst or subcarrier, sync to incoming sync.

A slow genlock mode is provided for those applications where fast-lock may upset the system.The slow-lock selector is located on the generator card sets.

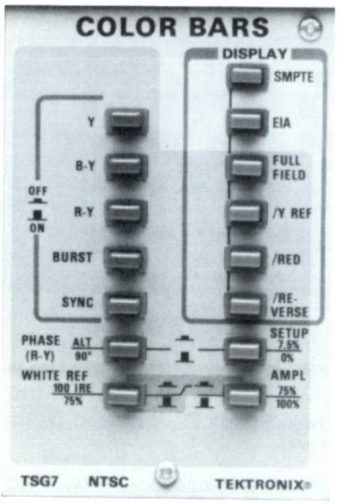
Genlock or external reference lock mode selection may be remotely controlled. Remote manual phasing of the SPG12 or SPG22 signal to an external source is possible in the internal mode. Vertical and/or horizontal timing are altered as in slow-lock operation. Front panel LED's are used to indicate generator lock status.

Internal adjustments permit some variation of burst and blanking widths on the burst flag, comp blanking, and black burst outputs. These adjustments are preset to conform to recognized standards. You can reduce widths initially to allow for the widening that sometimes occurs when the video signal is processed.

The subcarrier frequency accuracy is ±1 Hz when operated in the internal mode. An optional ±10 Hz oscillator (Option 10) is available for the 1410. A black burst output independent of all other outputs is provided. For NTSC systems, the VIRS (Vertical Interval Reference Signal) is factory programmed on line 19, Field 1 and 2 of the black burst when selected by a front panel switch on the SPG2. VIRS can be selected on line 18 if desired.



The SPG2 Genlock sync generator.



TSG7 Color Bars Generator

TSG7/TSG11/TSG21

Color Bars Generators

Color Bars Signals

SMPTE Color Bars (TSG7)

EIA (TSG7)

Fixed Full Field (TSG11/TSG21)

Full Field with Switchable Components

75% or 100% Amplitude

Split Field/Y Reference

Split Field/Red

Split Field Bars/Bars Reversed

The TSG7, TSG11 and TSG21 provide high-quality full field and split field color bars for the 1410 Series Signal Generators. The TSG7 operates independently from any other test signal installed in the mainframe. Its output is available simultaneously with all other test signal outputs. The composition of the signal can be altered by switching off Y, B-Y (U), R-Y (V), Burst, and Sync.

You may also select fixed or alternating R-Y (V) subcarrier phase, bar amplitude, white reference, and setup level (or pedestal).

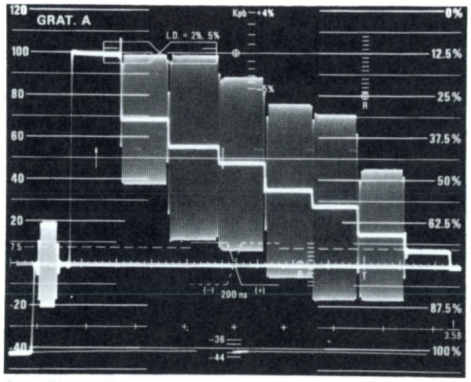
The /Y REF switch selects a split field display of color bars in the same sequence as full field, followed by the luminance portion of the color bars for the remainder of the field. The split can be ½ or ¾ field as selected by internal programming in the sync pulse generator. With this signal, you can check chrominance to luminance delay and picture monitor gray scale tracking while simultaneously evaluating color performance.

The /RED switch selects a split-field display of color bars, as in /Y REF, followed by red chrominance. (Same phase and amplitude, and at the same luminance level as the red bar.) Use this signal for adjusting VTR playback controls. Head equalization errors and noise are easily spotted on a red field. Other bar colors can be chosen by internal programming. The signal is also remotely switchable to color bars/white.

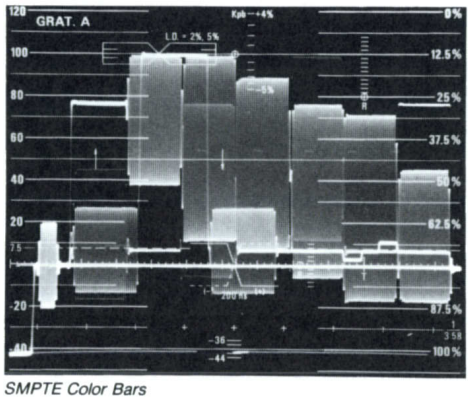
The /REVERSE switch selects a split field display of color bars as in /Y REF, followed by color bars in a reverse sequence. That is black, blue, red, magenta, green, cyan, yellow, white. This signal helps detect chrominance to luminance delay while viewing the kinescope of a color monitor/receiver. Reverse bars are also useful in detecting VTR velocity errors.

The TSG7 will produce color bars VIT on any VIT line desired. (VIT signals cannot be inserted on the program line. Use a 147A, 148, 148M, or 1910 for insertion of VITS on a program line.)

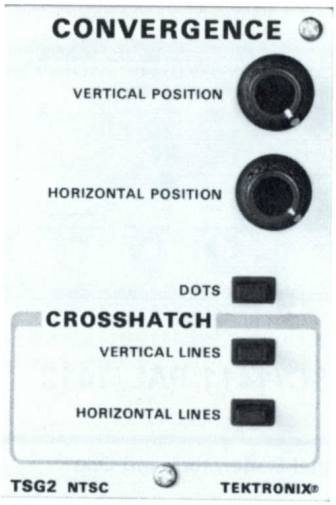
The SMPTE switch (TSG7) is used to select the alignment color bar test signal for television picture monitors. This signal is generated in accordance with the format outlined in SMPTE Engineering Committee Recommendations, ECR 1-1978. SMPTE bars provide an easy way to objectively adjust picture monitor chroma, hue, and brightness.



Color Bars/Y Reference



SMPTE Color Bars



TSG2 Convergence Generator

TSG2/TSG12

Convergence Test Signal Generators

Dots and Crosshatch

Dots Only

Vertical Lines Only

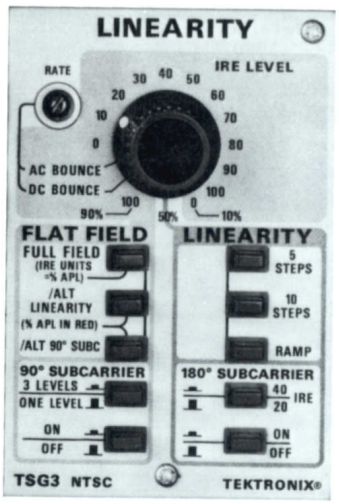
Horizontal Lines Only

Vertical and Horizontal Lines

Position Controls

The TSG2 and TSG12 provide high-quality convergence test signals for the 1410 Series signal generators. You can use them to determine picture monitor or camera scanning linearity, aspect ratio, and geometric distortion. Signals for the TSG2 conform to IEEE Standard 202.

Provision is made for on/off switching of the dots, vertical lines, and/or horizontal lines and for positioning vertical and horizontal lines. The signal output is located on the rear panel of the mainframe in which the test signal generator is installed. The convergence signal output is available simultaneously with all other test signal generator outputs.



TSG3 Linearity Signal Generator

TSG3/TSG13/TSG23

Linearity and Modulated Pedestal Test Generators

5 and 10 Step Staircase Signal
Ramp Signal
2 Modulation Amplitudes

One or Three Level Modulated Pedestal

Flat Field with 11 Fixed Levels

Ac and Dc Bounce

The TSG3, TSG13 and TSG23 provide high-quality linearity and modulated pedestal test signals for the 1410 Series signal generators.

Combine variable APL with either of these signals to measure nonlinear distortions. The generators operate independently of all other test signal generators installed in the mainframe, while the rear panel output is available simultaneously with all other test signal generators' outputs.

You can select the 5 step and 10 step staircase signals and the ramp signal with or without 180° subcarrier modulation for NTSC, or U subcarrier modulation for PAL and PAL-M. The subcarrier amplitude is front panel selectable at 20 IRE or 40 IRE on the TSG3, or at 140 mV and 280 mV on the TSG13 and TSG23. Applications include measuring differential phase and gain, dynamic gain, luminance linearity, and burse phase errors.

With the TSG3, the flat field signal can be used on all active picture lines with levels set by the IRE Level control (% peak white on the TSG13, TSG23) or flat field on four lines can be alternated with one line of linearity or modulated pedestal. When using the alternate mode APL is controlled by the IRE level control (% peak white on the TSG13, TSG23).

The ac Bounce position of the IRE level switch (TSG3) or the % peak white switch (TSG13, 23) provides a signal in which the active portion of each line (excluding sync) changes APL levels at a rate determined by the rate control (1 to 30 second intervals).

For the TSG3, amplitude of the bounce excursions is fixed at 0 to 100 IRE in flat field mode and 10% to 90% APL in alternate modes. Blanking level remains fixed at 0 V. To check ac coupled circuitry use ac bounce.

With the switch set to dc bounce, ac bounce occurs as described above. In addition, the entire signal changes dc level in the opposite direction at the same rate resulting in no change in average dc level. Clamp circuits may be checked using dc bounce.

TSG5/TSG15/TSG25

Pulse and Bar Generators

Pulse and Bar Overlay

Full and Half Amplitude Pulse and Bar

Field Squarewave and Window

Modulated Pulse and Modulated Bar

Front Panel Selection of 2T, T, and T/2 Pulse Width and Bar Risetime

The TSG5, TSG15, and TSG25 are sin² pulse and bar television test signal generators designed for use with the 1410 Series signal generators. They're well suited for testing on equipment manufacturers' production lines and for testing of television transmitters, common carrier microwave and wire lines, and studio distribution systems. Front panel controls provide most test signal options, while internally selectable options provide additional versatility.

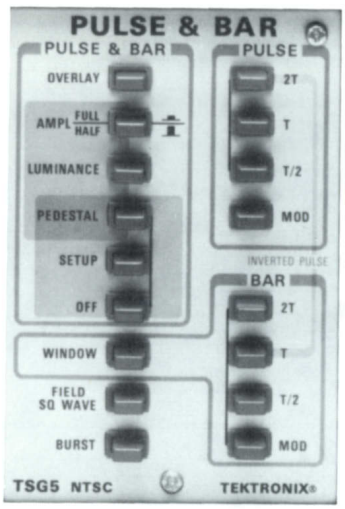
The pulse and bar test signal consists of a sin² modulated pulse, a sin² pulse, and luminance bar. The pulse and bar overlay mode lets you conveniently compare pulse to bar ratio without manipulating waveform monitor controls.

The inverted and noninverted 2T pulses may be overlaid to compare shape and HAD (half amplitude duration). This capability is particularly useful in detecting quadrature distortion which results from envelope detection of the RF modulated video signal. The pulse and bar test signal is also useful in measuring line time and short time distortions.

For sin² pulse signals, three self-cancelling switches permit independent selection of pulse half amplitude duration (2T, T, T/2) independent of bar risetime. In the bar mode, four self-cancelling switches permit selection of luminance bar risetime (2T, T, T/2) or modulated bar.

Full or half amplitude pulse and bar test signals can be provided with or without pedestal or setup (the TSG15 and TSG25 do not offer setup capability). For the TSG5, full amplitude is 100 IRE units with no setup. Half amplitude is 50 IRE with no setup. For the TSG15 and TSG25, full amplitude is 100% (700 mV) with no setup. Half amplitude is 50% (350 mV) with no setup.

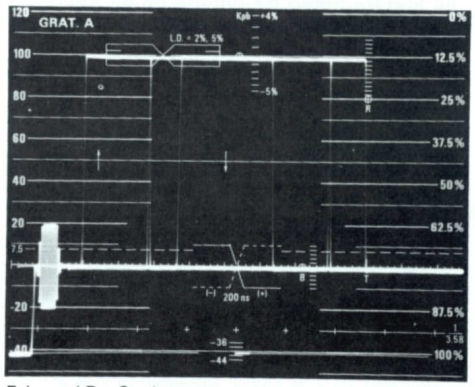
The luminance pulse, luminance bar, and luminance components of the modulated pulse and modulated bar may be switched off to provide chrominance pulse and chrominance bar. The chrominance pulse and bar may be placed on a pedestal (50 IRE for the TSG5, 50% for the TSG15 and TSG25) to prevent chrominance from extending below blanking level.



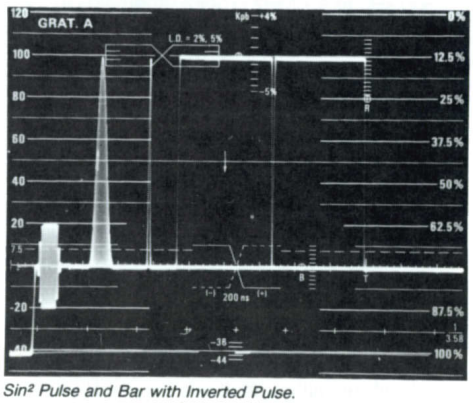
TSG5 Pulse and Bar Signal Generator

Use the standard field squarewave (with full amplitude and no setup) to measure field time distortion, and the window signal to measure line time distortion and picture monitor smearing. You can switch the color burst off without affecting the chrominance components of the test signals.

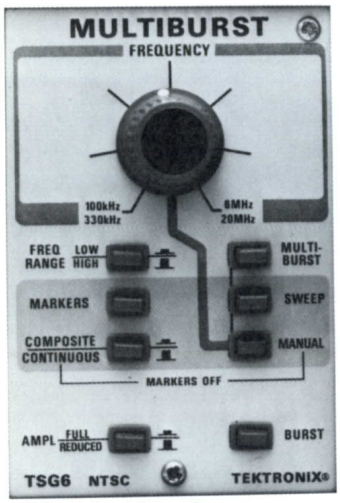
Use the TSG5 for measuring overall gain, transient response, line and field time tilt, and chrominance to luminance delay and gain.



Pulse and Bar Overlay.



Sin² Pulse and Bar with Inverted Pulse.



TSG6 Multiburst Signal Generator

TSG6/TSG16/TSG26

Multiburst Signal Generators

Multiburst Signal

Controlled Risetime Burst Packets

Last Burst Frequency Variable

Manual and Field Swept Frequency Signals to 20 MHz

Markers for Both Frequency and Amplitude Reference

Full and Reduced Amplitude on all Signals

The TSG6, TSG16 and TSG26 are television multiburst and video sweep test signal generators designed for the 1410 Series signal generators.

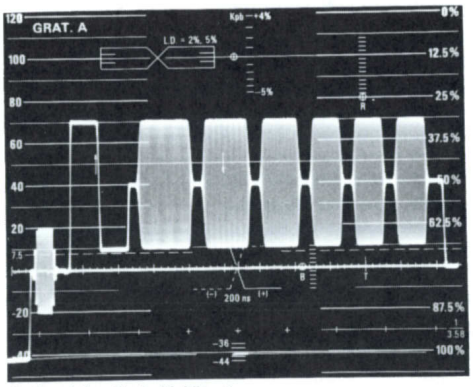
They feature front panel controls for most test signal options, plus special Remote functions for additional versatility. They can be used in many testing applications, including equipment manufacture and microwave or long-line transmission systems.

Performance advances include reduction in harmonic content of sinewave signals and skirt energy associated with gating burst packets. Phase modulation of the burst packets aids ease of measurement by filling in shape of packets. Two ranges of multiburst frequencies are available: the 500 kHz to 4.1 MHz (TSG6) range aids in testing television transmitters and common carrier links, while the 1.25 MHz to 12 MHz range is used in testing television studio equipment and cabling.

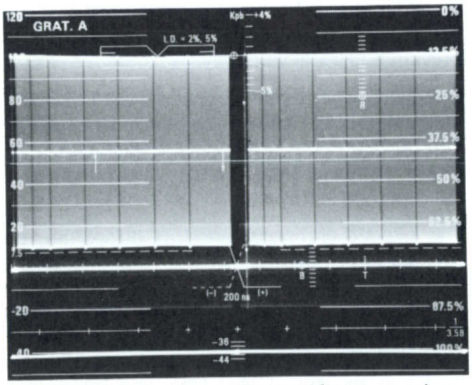
Use these new generators where nonlinearities make reduced amplitude test signals desirable. The reduced amplitude multiburst signal allows accurate testing of video tape record/playback systems, since it is not subject to the false distortion of the full amplitude multiburst that often occurs in such applications.

Using the front panel controls, you can select a high or low-frequency band for each operating mode. SWEEP, allows selection of field sweep signal with or without markers. MARKERS inserts amplitude/frequency markers in Sweep, and amplitude markers in Composite/Manual. BURST allows insertion/deletion of color burst on composite video for use with systems that operate differently when burst is present. COMPOSITE/-CONTINUOUS determines whether sync, blanking, and a pedestal will be added to the sweep and manual signals.

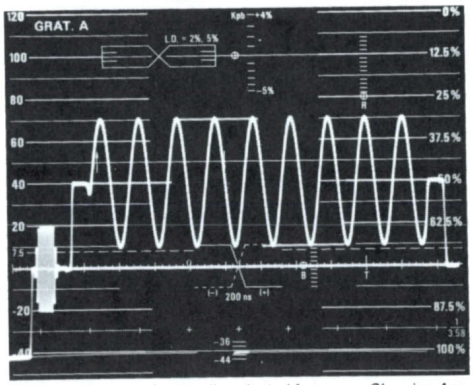
MANUAL selects a fixed-frequency sinewave with frequency determined by the Frequency control and Frequency Range switch. AMP allows selection of either full or reduced amplitude in all operating modes, MULTIBURST selects line-rate discrete-frequency packets with reference insertion levels.



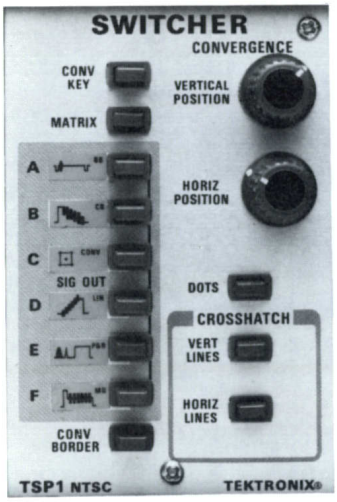
Reduced Amplitude Multiburst



Field Rate Sweep showing amplitude and frequency markers



Line Rate Display of manually selected frequency Showing Amplitude Marker



TSP1 Signal Switcher

TSP1/TSP11/TSP21

Switchers and Convergence Generators

Single Switchable Output for Two to Six Generated Signals

Blanking, Sync and Burst Insertion for External Signal

Matrixing — Eight Programmed Display Formats to up to Six Sequential Signals

Convergence Border

Convergence Key

Crosshatch or Dots

Combined Crosshatch and Dots

The TSP1, TSP11, and TSP21 combine the capabilities of a test signal switcher and convergence signal generator in a single unit. They simplify and expand the uses of the 1410 Series signal generators.

From a single, electronically switched output, you have access to all the test signals (from two to six) generated by the card sets in the mainframe. Meanwhile, you may continue to use the individual generator card sets' parallel outputs, so no restrictions are imposed on an established system. As an added feature, one of the input signals can be external (composite or noncomposite). All of the switcher inputs are provided with clamp circuitry.

Eight different matrixes are stored in the PROM. This signal matrixing capability, combined with the full-field mode of the TSP1 presents several combinations of signals sharing the full field display.

Most of TSP1 switching functions can be remotely controlled through the mainframe's Remote connector.

CHARACTERISTICS

SYNC PULSE GENERATORS

1410 Subcarrier — Frequency (Fsc): 3.579545 MHz ±1 Hz. Pull-in Range: Fsc ±20 Hz.

1410 Option 10 Subcarrier — Frequency (Fsc): 3.579545 MHz ±10 Hz. Pull-in Range: Fsc ±50 Hz.

1411 Subcarrier — Frequency (Fsc): 4.43361875 MHz ±1 Hz. Drift ≤1 part in 10^7 per week. Pull-in Range: Fsc ±20 Hz.

1412 Subcarrier — Frequency (Fsc): 3.57561149 MHz ±1 Hz. Drift ≤1 part in 10^7 per week. Pull-in Range: Fsc ±20 Hz.

PULSE OUTPUTS

Output Level (into 75 Ω) — 4 V (1410), 1 V, 2 V, or 4 V (selectable, 1411 and 1412) ±0.2 V.

Return Loss — ≥30 dB to 5 MHz.

Risetime and Falltime — 10% to 90% (Linear Ramp). 140 ns, (1410, 1422). 250 ns (1411-Other values internally selectable).

Jitter — Linelock: ≤10 ns. Subcarrier Lock: ≤4 ns.

Composite Sync — Equalizing Pulse Duration: 2.3 μs (2.38 μs-1412) ±100 ns. Field Sync: Duration 27.0 μs ±200 ns (27.2 μs ±100 ns-1411). Interval Between Field Sync Pulses: 4.77 μs (4.8 μs-1411, 1412) ±100 ns. Line Sync Duration: 4.7 μs ±100 ns.

Comp Blanking — Line Blanking Duration: 10.7 μs (12.0 μs-1411, 11.1 μs-1412) nominal, adjustable 9 to 12 μs. Field Blanking Duration: 20 lines (25 lines-1411, 21 lines-1412) nominal, adjustable 16 to 21 lines (16 to 25 lines-1411).

Burst Flag — Delay from Line Sync: Adjustable. Duration: 2.51 μs ±50 ns (2.25 μs ±100 ns-1411) adjustable.

Horizontal Line Drive — Duration: Start of line blanking to end of line sync ±100 ns.

Vertical Drive — Duration: 9 lines (1410, 1412) 7 ½ lines (1411).

Field REF — Position: Field one, line 11 or field three, line ten (internally selectable 1410); field one line seven (1411); field one line eight (1412).

PAL Pulse, Phasing (1411, 1412 only) — Negative transition coincident with leading edge of line sync on either +V or −V lines. Factory set to +V. Duration: 4.7 μs, within 0.2 μs. Level: 2 V 75 Ω at H/2 Rate.

PAL Pulse Squarewave (1411, 1412 only) — May be internally selected in place of pulse. Level: 1 V, 75 Ω, H/2 rate. Phasing Transition is coincident with leading edge of line sync. Polarity may be high or low during −135° burst lines.

V/2 (1411, 1412 only) — Level: 1 V, 75 Ω. Rate: 25 Hz (1411) 30 Hz (1412) squarewave. Phasing: Positive during fields 2 and 4 (1411). 1 and 3 (1412).

V/4 (1411, 1412 only) — Level: 1 V, 75 Ω Rate: 12.5 Hz (1411); 15 Hz (1412) squarewave. Phasing: Positive during fields 1 and 4 (1411); 1 and 2 (1412).

64H (1411 and 1412 only) — Level: 1 V, 75 Ω. Frequency: 1 MHz (1411); 1.006993 MHz (1412).

SUBCARRIER OUTPUT

Amplitude — 2 V p-p into 75 Ω. Return Loss: ≥30 dB to 5 MHz.

BLACK BURST OUTPUT

Amplitudes — Sync: 286 mV ±3.57 mV (1410); −300 mV ±3 mV (1411, 1412) from blanking. Burst: 286 mV ±2.86 mV (1410). Absolute 300 mV ±9 mV. Relative: Alternate burst amplitudes equal within 1% (1411, 1412). Setup 53.57 mV ±3.57 mV (1410), 0% (1411), 50 mV ±2.5 mV (1412).

VIR Signal (1410 only) — Chrominance: Amplitude 286 mV ±2.85 mV (40 IRE); phase within 0.5° of burst; envelope risetime Sin^2 shaped 1 μs ±150 ns. Luminance: Setup level 53.57 mV ±3.57 mV (7.5 IRE ±0.5 IRE); gray level 357 mV (50 IRE ±0.5 IRE); chroma pedestal 500 mV ±5 mV (70 IRE ±0.7 IRE); risetime and falltime Sin^2 shaped, 250 ns ±39 ns.

GENLOCK

Input Configuration — 75 Ω loop-through with return loss: ≥−46 dB to 5 MHz (1410); ≥40 dB to 7 MHz (1411); ≥40 dB to 5 MHz (1412).

Input Requirements — 1 V nominal composite video or black burst, sync negative. Sync Amplitude: Nominal ±6 dB. Burst Amplitude: nominal ±12 dB. Burst Sync Ratio: Within 6 dB.

Subcarrier Phase Range — 360° via front-panel goniometer.

Line Sync Delay Range — Adjustable to advance output sync ≥10 μs or delay ≥4 μs (internal adjustment). A front panel screwdriver adjustment provides a delay/advance range of ±0.5 μs.

Stability (Over Ambient Temperature Range 0°C to ±50°C) — Line Lock: Within 70 ns. Subcarrier Lock: Within 35 ns.

Field/Frame Sync — Fast Lock: Direct-acting in one field. Slow Lock: One line/field slew.

Loss of Lock — Indicated by front-panel LED's (automatic switching to full or partial internal).

EXTERNAL REFERENCE

Input Configuration — 75 Ω loop-through.

Subcarrier Input Requirements — Amplitude: 1.0 V to 4.0 V p-p. Frequency fsc: ±10 Hz. Return Loss: ≥46 dB to fsc.

Comp Sync Input Requirements — Amplitude: 2.0 V to 8.0 V p-p. Polarity: Negative.

PAL Pulse Input — Amplitude: 1.0 V to 8.0 V p-p, negative going. Waveshape: Pulse or squarewave. Timing: Pulse duration ≥4 μs. Squarewave Rate: H/2. Phasing: Pulse-negative going transitions coincident with start of line sync on either a +V or −V line (1411, 1412 only).

Loss of Lock — Indicated by front-panel LED indicators. Automatic switching to partial or full internal reference.

Subcarrier Stability — Output follows input.

Line Sync Delay Range — Adjustable to advance output sync ≥10 μs or delay ≥4 μs (internal adjustment). A front panel screwdriver adjustment provides a delay/advance range of ±0.5 μs.

Subcarrier Phase Range — 360° via front-panel goniometer.

COLOR BAR GENERATORS (TSG7, TSG11, TSG21)

Luminance Signal Accuracy — Within 1% or 1.5 mV, whichever is greater.

Chrominance Accuracy — Absolute Amplitudes: Within 3% (all subcarrier components). Relative Amplitudes: Within 1% of the red chrominance bars or 1 mV plus p-p residual subcarrier amplitude, whichever is greater.

Full Field Displays — Bar Width: 6.45 μs (TSG7); 6.5 μs (TSG11); 6.6 μs (TSG21). White Bar Risetime: 130 ns, +20 ns, −10 ns (TSG7); 115 ns ±15 ns (TSG11); 125 ns ±20 μs (TSG21). Time Difference Between Chroma and Lum Channels: ≤20 ns.

CONVERGENCE TEST SIGNAL GENERATOR (TSG2, TSG12)

Displays Available — Crosshatch, vertical lines only, horizontal lines only, dots only, and crosshatch plus dots (dots appear centered in the rectangles formed by the crosshatch pattern). Horizontal and vertical positioning.

Risetime and Falltime — Pulses and setup 135 ns ±15 ns (TSG2); 115 ns ±15 ns (TSG12).

Pulse Amplitude — 77 IRE ±3 IRE (TSG2); 525 mV ±25 mV (TSG12).

LINEARITY TEST SIGNAL GENERATOR (TSG3, TSG13, TSG23)

Luminance Risetime — 250 ns ±39 ns (TSG3); 250 ns ±50 ns (TSG13, TSG23).

Five-Step Signal — Step Amplitudes Nominal: 143 mV (TSG3); 140 mV (TSG13, TSG23). Relative: Largest within 1% of smallest.

Ten-Step Signal — Step Amplitudes Nominal: 71.5 mV (TSG3); 70 mV (TSG13, TSG23). Relative: Largest within 1% of smallest.

Ramp Signal — Linearity: ±1%.

Linearity Subcarrier — Absolute Amplitudes: ±3%.

Relative Amplitudes: ±1%. 20 IRE: 143 mV (TSG3); 140 mV (TSG13, TSG23). 40 IRE: 285.7 mV (TSG3); 280 mV (TSG13, TSG23).

Differential Gain: ≤0.5%. Phase: 180° ±1°. Differential Phase: 0.1°.

Subcarrier Envelope — Risetime: 400 ns ±60 ns (TSG3, TSG23); 350 ns ±50 ns (TSG13).

Modulated Pedestal — 90° Subcarrier. Amplitude: 1 level is 5 IRE to 20 IRE (TSG3); low level is internally adjustable (TSG13, TSG23). 3 Levels: 20, 40 and 80 IRE (TSG3); 140 mV, 420 mV and 700 mV (TSG13, TSG23).

Bounce Modes — Ac: Rate, 1/60 to ½ Hz. Dc: Rate, slow 1/60 to ½ Hz. Dc Rate. Fast Selectable: Line rate, field rate, or frame rate.

PULSE AND BAR GENERATOR (TSG5, TSG15, TSG25)

	Full Amplitude	Half Amplitude
Luminance Bar Amplitude Setup Off	714.3 mV ±7.1 mV	357.1 mV ±3.6 mV
(TSG5)		
(TSG15, TSG25)	700.0 mV ±7.0 mV	350.0 mV ±5.3 mV
Modulated Bar Amplitude Setup Off		
Luminance	357.1 mV	178.6 mV
(TSG5)	±3.6 mV	±1.8 mV
(TSG15, TSG25)	350.0 mV ±3.5 mV	175.0 mV ±1.8 mV
P-P Chrominance	714.3 mV	357.1 mV
(TSG5)	±14.3 mV	±7.1 mV
(TSG15, TSG25)	700.0 mV ±14.0 mV	350.0 mV ±7.0 mV
Pulse Amplitude Setup Off		
2T (TSG5)	714.3 mV ±7.1 mV	357.1 mV ±5.4 mV
−2T, T	714.3 mV ±10.7 mV	357.1 mV ±7.1 mV
T/2	714.3 mV ±14.3 mV	347.1 mV ±14.3 mV
Modulated	714.3 mV ±7.1 mV	357.1 mV ±5.4 mV
2T (TSG15, TSG25)	700.0 mV ±7.0 mV	350.0 mV ±5.3 mV
−2T, T	700.0 mV ±10.5 mV	350.0 mV ±7.0 mV
T/2	700.0 mV ±14.0 mV	340.0 mV ±14.0 mV
Modulated	700.0 mV ±7.0 mV	350.0 mV ±5.3 mV
Pulse to Bar Ratio		
2T	1:1 ±0.005	1:1 ±0.01
−2T, T	1:1 ±0.01	1:1 ±0.02
T/2	1:1 ±0.02	1:1 ±0.04
Modulated Pulse to Modulated Bar	1:1 ±0.01	1:1 ±0.02

Modulated Pulse and Bar — Chrominance-Luminance Gain: 3.6 mV (3.5 mV for TSG15, TSG25) maximum amplitude difference of peak chrominance and peak luminance.

Delay Residual: 5 ns maximum.

Window — Line Timing: Bar Timing.

Field Timing: White lines from line 67 to line 218 (lines 65 to 270 for TSG15, 64 to 215 for TSG25) each field.

Field Tilt: 0.5% maximum.

Field Squarewave — Field Timing: White lines 75 to 206 (lines 65 to 221 for TSG15, lines 64 to 215 for TSG25).

Field Tilt: 0.5% maximum.

Pedestal — Amplitude Luminance Off or Half Amplitude: 357.1 mV ±7.1 mV (TSG5) 350 mV ±7 mV (TSG15, TSG25).

MULTIBURST SIGNAL GENERATOR (TSG6, TSG16, TSG26)

	Low Range	High Range
Multiburst Frequencies (TSG6)	500 kHz ±3% 1.25 MHz ±3% 2.00 MHz ±3% 3.00 MHz ±3% 3.58 MHz ±3% 4.10 MHz ±3%	1.25 MHz ±3% 3.50 MHz ±3% 5.50 MHz ±3% 8.00 MHz ±3% 10.0 MHz ±3% 12.0 MHz ±3%
(TSG16)	500 kHz ±3% 1.00 MHz ±3% 2.00 MHz ±3% 4.00 MHz ±3% 4.80 MHz ±3% 5.80 MHz ±3%	1.00 MHz ±3% 3.00 MHz ±3% 5.00 MHz ±3% 8.00 MHz ±3% 10.0 MHz ±3% 12.0 MHz ±3%
(TSG26)	500 kHz ±3% 1.00 MHz ±3% 2.00 MHz ±3% 3.00 MHz ±3% 3.58 MHz ±3% 4.20 MHz ±3%	1.00 MHz ±3% 3.00 MHz ±3% 5.50 MHz ±3% 8.00 MHz ±3% 10.0 MHz ±3% 12.0 MHz ±3%
Amplitude (First Multiburst Packet) Full (TSG6)	643 mV (90 IRE) ±20 mV	643 mV ±25 mV
(TSG16, TSG26)	700 mV ±21 mV	700 mV ±28 mV
Reduced (TSG6)	428 mV (60 IRE) ±12 mV	428 mV ±16 mV
(TSG16, TSG26)	420 mV ±12 mV	420 mV ±16 mV
Flatness, Reduced and Full (TSG6)	10 mV or less	16 mV or less
(TSG16, TSG26)	10 mV or less	17.5 mV or less
Packet Envelope Risetime	400 ns ±60 ns	400 ns ±60 ns
Burst Phasing	Phase shifted at field rate to provide filled-in burst packets.	
Sweep/Manual Sinewave Frequencies		
Start	100 kHz minimum	330 kHz minimum
Stop	6 MHz ±10%	20 MHz ±10%
Amplitude at First Marker (TSG6)	643 mV ±20 mV	643 mV ±25 mV
(TSG16, TSG26)	700 mV ±21 mV	700 mV ±28 mV
Reduced (TSG6)	428 mV ±12 mV	428 mV ±16 mV
(TSG16, TSG26)	420 mV ±12 mV	420 mV ±16 mV
Flatness[3] Full and Reduced (TSG6)	10 mV	15 mV to 12 MHz 20 mV to 20 MHz
(TSG16, TSG26)	10 mV	17.5 mV to 12 MHz 21.0 mV to 20 MHz
Markers Frequencies	500 kHz ±3%*1 1.0 MHz ±3%*1 2.0 MHz ±3%*1 3.0 MHz ±3%*1 4.0 MHz ±3%*1 5.0 MHz ±3%*1	1.0 MHz ±3%*1 2.0 MHz ±3%*1 4.0 MHz ±3%*1 6.0 MHz ±3%*1 8.0 MHz ±3%*1 10.0 MHz ±4%*1 12.0 MHz ±4%*2 14.0 MHz ±6%*2 16.0 MHz ±7%*2 18.0 MHz ±7%*2 20.0 MHz ±7%*2
Multiburst/Manual (Last Burst Variable Mode) Frequency Range (TSG6, TSG26)	<3.8 MHz to >4.5 MHz	<14 MHz to 20 MHz ±10%
(TSG16)	<5.0 MHz to 6.0 MHz ±10%	<14 MHz to 20 MHz ±10%
Accuracy	±0.2% short term	±1% short term

	Low Range	High Range
Amplitude (Markers & Pedestal all Modes) Markers Relative to Pedestal Level		
Full (TSG6)	±321 mV ±1%	±321 mV ±1%
(TSG16, TSG26)	±350 mV ±1%	±350 mV ±1%
Reduced (TSG6)	±214 mV ±1%	±214 mV ±1%
(TSG16, TSG26)	±210 mV ±1%	±210 mV ±1%
Pedestal Level		
Full (TSG6)	393 mV ±1%	393 mV ±1%
(TSG16, TSG26)	350 mV ±1%	350 mV ±1%
Reduced (TSG6)	286 mV ±1%	286 mV ±1%
(TSG16, TSG26)	350 mV ±1%	350 mV ±1%
Risetime	250 ns ±50 ns	250 ns ±50 ns
Harmonic Distortion (Single Frequency Relative to Fundamental (TSG6, TSG26)	−44 dB, 0.3 to 4.2 MHz −40 dB, 0.1 to 0.3 MHz −40 dB, 4.2 to 6.0 MHz	−38 dB, 0.33 to 6.0 MHz −36 dB, >6 to 20 MHz
(TSG16)	43 dB, 300 kHz to 5.0 MHz −40 dB, 100 kHz to 300 kHz −40 dB, 5.0 MHz to 6.0 MHz	−38 dB, 330 kHz to 6.0 MHz −36 dB, 6 MHz to 20 MHz

[1] Within one television line either side of the marker.

[2] Above 10 MHz, difference frequency between markers is 2 MHz ±400 kHz.

[3] Maximum-minimum diode detected peak-to-peak voltages.

SIGNAL SWITCHER (TSP1, TSP11, TSP21)

Input Signal — Amplifier Limits: 1.4 V p-p.

Input Return Loss: ⩾30 dB, to 5 MHz.

Input Isolation: ⩾50 dB, internal inputs.

Input Impedance: 75 Ω.

Switcher Output Signal — Timing: Same as inputs, delayed by ±10 ns (10° to 20° of subcarrier).

Amplitudes: Within 2% of inputs.

Blanking dc Level: 0 V ±100 mV.

Relative Blanking Level: Within 15 mV, between signals.

Added Distortion — Noise: <60 dB, to 5 MHz.
Residual Subcarrier: <1 mV.

Differential Gain: <0.5%.

Differential Phase: <0.3°.

Luminance Linearity: 1%.

Pulse to Bar Ratio: 2T: 1:1 ±0.5%.

Tilt: <1%, line or field.
Flatness: 1% to 5 MHz, 2% to 10 MHz, 4% to 20 MHz.

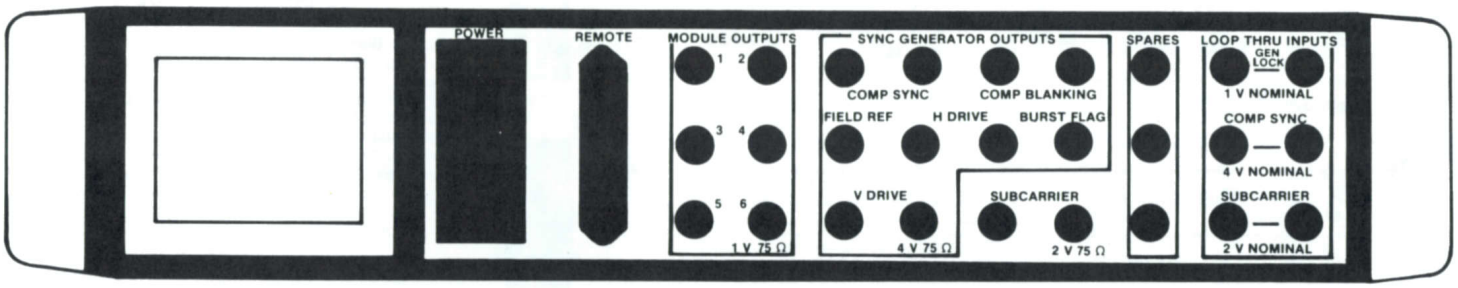
Clamping — Aberrations: <10 mV, at burst gate time.
Output Return Loss: ⩾30 dB to 5 MHz.

CONVERGENCE

Displays Available — Crosshatch, vertical lines only, horizontal lines only, dots only, and crosshatch plus dots (dots appear centered in the rectangles formed by the crosshatch pattern). Horizontal and vertical positioning.

Risetime and Falltime — Pulses and setup 135 ns ±15 ns (TSP1), 115 ns ±15 ns (TSP11), 125 ns ±20 ns (TSP21).

Pulse Amplitude — 77.5 IRE ±3 IRE (TSP1), 525 mV ±25 mV (TSP11, TSP21).



Rear Panel of the 1410

AC POWER

Mains Voltage Ranges — 90 V ac to 112 V ac. 106 V ac to 132 V ac, 180 V ac to 224 V ac and 212 V ac to 250 V ac. Factory set at 106 V ac to 132 V ac (1410, 1412), 212 V ac to 250 V ac (1411).

Power Consumption — 130 W maximum.

Mains Frequency — 47 Hz to 63 Hz.

ENVIRONMENTAL CHARACTERISTICS

Temperature Range — Operating: 0°C to +50°C. Nonoperating: −40°C to +65°C.

Altitude Range — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 200 m (50,000 ft).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	482.6	19.0
Height	88	3.5
Depth	487.7	19.2
Weight (w/Plug-ins)	**kg**	**lb**
Net≈	9.7	21.2
Rackmount	13.8	30.0

SAFETY CERTIFICATIONS

Underwriters Laboratories, Inc.: Listed, 242T; Canadian Standards Association: Certified, LR37158; International Electrotechnical Commission (IEC 348): Certified by Tektronix, Inc.

INCLUDED ACCESSORIES

Extender board (670-4441-02); 1.5A fuse (159-0016-00); .75A fuse (159-0042-00). 1410R 1411R and 1412R include rackmount hardware; instruction manual.

ORDERING INFORMATION

The 1410 (NTSC) and 1411 (PAL) Sync Pulse and Test Signal Generator Series card set construction allows ordering just the capabilities needed while leaving room for future expansion. For easy ordering of a 1410 or 1411 Generator, follow the steps listed here.

1. Select the functions needed. Choose either a rackmount or a cabinet style mainframe for the 1410 (NTSC) or 1411 (PAL) generator. Choose up to a total of five test signal generators and signal switchers to be installed in the mainframe.
2. Check the 1410 or 1411 Standard Configuration charts to see if the combination selected is equivalent to a standard Option 03 or Option 04. If it is, order the Option 03 or Option 04. Do not combine any other options with Option 03 or Option 04. (Except that Option 10 for 1410C and 1410R may be combined with Option 03 or Option 04). All 1410 and 1411 generators ordered in this manner are shipped with the test signal generators and signal switchers installed and fully calibrated in the mainframe.
3. If the desired combination is not one of the standard configurations, order a mainframe and order an alphanumeric option for each test signal generator or signal switcher in the desired combination. Each test signal generator or signal switcher ordered in this manner will be shipped installed and fully calibrated in the mainframe.
4. To add functions to an existing 1410 or 1411 generator order the desired test signal generator or signal switcher by its product name (e.g. TSG3). Each generator ordered in this manner will be shipped individually and installation into the mainframe is the responsibility of the customer.
5. When ordering more than one 1410 or 1411 Generator package on the same purchase order be sure to indicate the appropriate options to be included in each package.

1410C/1410R NTSC PACKAGES STANDARD CONFIGURATIONS

	Option 03	Option 04
TSG2 (Convergence)	x	
TSG3 (Linearity)	x	x
TSG5 (Pulse and Bar)		x
TSG6 (Multiburst)		x
TSG7 (Color Bars)	x	x
TSP1 (Switcher)		x

1410C NTSC Mainframe and SPG2 (Cabinet Version) **$5,130**

1410R NTSC Mainframe and SPG2 (Rackmount Version) **$5,130**

Option 03*1 — NTSC Package Installed and Tested Together ..... **+$3,230**

Option 04*1 — NTSC Package Installed and Tested Together ..... **+$7,730**

Option 10 — ±10 Hz Color Subcarrier Frequency Accuracy ..... **−$405**

Option 2C — Adds TSG2 Installed ..... **+$495**

Option 3L — Adds TSG3 Installed ..... **+$1,225**

Option 4P — Adds TSG5 Installed ..... **+$1,595**

Option 4M — Adds TSG6 Installed ..... **+$2,220**

Option 1B — Adds TSG7 Installed ..... **+$1,745**

Option 1S — Adds TSP1 Installed ..... **+$1,535**

**1 Can not be combined with any other option except may be combined with Option 10.*

TSG2 Convergence Generator **$520**

TSG3 Linearity Generator **$1,285**

TSG5 Pulse and Bar Generator **$1,680**

TSG6 Multiburst Generator **$2,330**

TSG7 Color Bars Generator **$1,830**

TSP1 Switcher **$1,610**

1411C/1411R PAL PACKAGES STANDARD CONFIGURATIONS

	Option 03	Option 04
TSG11 (Color Bars)	x	x
TSG12 (Convergence)	x	
TSG13 (Linearity)	x	x
TSG15 (Pulse and Bars)		x
TSG16 (Multiburst)		x
TSP11 (Switcher)		x

1411C PAL Mainframe and SPG12 (Cabinet Version) **$5,130**

1411R PAL Mainframe and SPG12 (Rackmount Version) **$5,130**

Option 03*1 — PAL Package Installed and Tested Together ..... **+$3,000**

Option 04*1 — PAL Package Installed and Tested Together ..... **+$7,500**

Option 1B — Adds TSG11 Installed ..... **+$1,500**

Option 2C — Adds TSG12 Installed ..... **+$495**

Option 3L — Adds TSG13 Installed ..... **+$1,225**

Option 4P — Adds TSG15 Installed ..... **+$1,595**

Option 4M — Adds TSG16 Installed ..... **+$2,220**

Option 1S — Adds TSP11 Installed ..... **+$1,535**

**1 Can not be combined with any other option.*

TSG11 Color Bars Generator **$1,575**

TSG12 Convergence Generator **$520**

TSG13 Linearity Generator **$1,285**

TSG15 Pulse and Bar Generator **$1,680**

TSG16 Multiburst Generator **$2,330**

TSP11 Switcher **$1,610**

1412R PAL-M PACKAGES

1412R PAL-M Mainframe and SPG22, TSG21 (Rackmount Version) **$7,270**

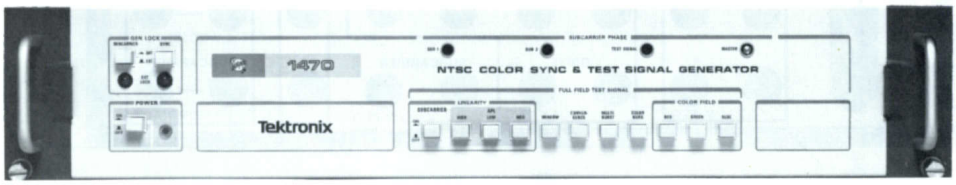
Option 05 — Adds TSG23/25/26/TSP21 Installed .. **+$8,620**

OPTIONAL ITEMS (FOR ALL CONFIGURATIONS)

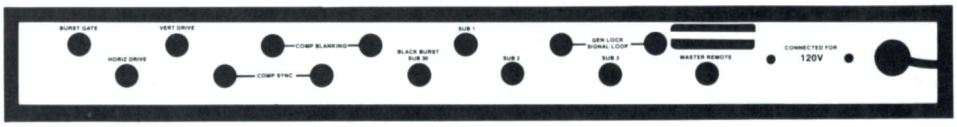
One Wide Blank Panel — Order 333-2171-00 ..... **$1.35**

Conversion Kit for SMPTE Bars — for TSG1 Module Order 040-1010-00 ..... **$375**

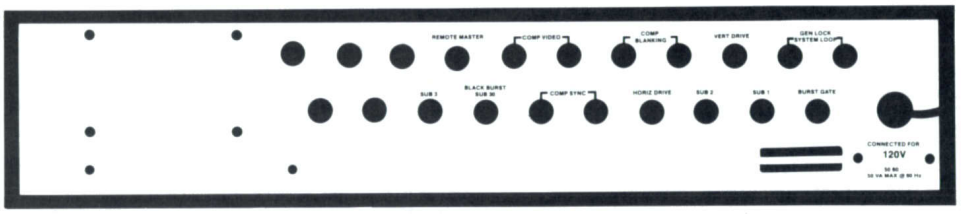
1474 NTSC Color Sync Generator



1470 NTSC Color Sync and Test Signal Generator



1474 Rear Panel



1470 Rear Panel

1470/1474

Full Color Sync Generator with Gen-Lock

Locks to Most Helical Scan VTRs

Simple to Operate

Compact and Economical

Full Selection of Sync and Timing Signals

Simplified Timing Via Multiple Subcarrier Phasing Controls

The 1470 Sync and Test Signal Generator is a compact, full color, gen-lock sync generator providing a full selection of high quality test signals.

The 1474 is identical in performance to the 1470 with the exception of test signals which, in the interest of economy, are not included. Both products have color gen-lock compatible with composite video from all normal sources including most helical scan video tape recorders.

The 1470 and 1474 can operate as master-sync generators or as units fully or partially timed from external sources. Color gen-lock capable of locking to most helical scan VTRs is a standard feature.

Front-panel pushbutton selection of external synchronization is provided. In external mode, the 1470 and 1474 automatically lock on composite video (1 V), composite sync (−4 V), or reference subcarrier (2 V). Two front-panel lights show subcarrier and/or sync external lock. Lights out indicate a switch to internal standard.

1470 Test Signal Functions

To simplify your test signal selection and speed testing operations, the 1470 has push button selection of test signals. All test signal push buttons, except the color field selectors, are self-cancelling. Each test signal provides aberration-free transitions and accurate flat levels.

Color Bars

The 1470 provides full-field color bars signals useful for color monitor adjustments, VTR tape lead in, and system checks.

Color Fields

Red, green, and blue color-field signals are provided for checking purity on color monitors/receivers that do not have individual gun on/off controls. These signals may also be used to provide a color background source. The red, green, and blue selectors may be used simultaneously to provide yellow, cyan, magenta, and white full field signals.

Linearity (Staircase)

Staircase signal with selection of high, medium, or low APL. Staircase subcarrier may be switched on or off from the front panel.

Test Signals

Test Signals available include: Window, Convergence Multiburst.

Window signals are suitable for measuring both line time and field time distortion. Convergence test signals are used to check color monitor convergence and linearity, and camera scanning linearity. Multiburst signals are used to check system frequency response.

Both the 1470 and 1474 are configured for rackmounting and are shipped ready to install in a 19 inch rack.

CHARACTERISTICS

SYNC GENERATORS OUTPUTS (1470/1474)

Horizontal Blanking — Leading Edge: 2.2 μs to 0.6 μs before the leading edge of sync. Trailing Edge: 9.1 μs to 10.7 μs after the leading edge of sync.
Horizontal Drive — Leading Edge: 2.2 μs to 0.6 μs before the leading edge of sync.
Vertical Blanking — 20 or 21 lines.
Subcarrier Phase Controls — Composite Test Signals: Subcarrier 1 and 2. Blackburst: Independent adjustment range of ≈120°, and jumpers allow a full 360° shift in 90° steps. Gen-Lock Master: Independent 360° front panel adjustment and 100° remote control, via a rear-panel BNC connector.

GEN-LOCK

Composite Sync — Output Level Into 75 Ω: 4 V ±0.5 V. Risetime and Falltime: 140 ns nominal.
Composite Blanking — Output Level Into 75 Ω: 4 V ±0.5 V. Field Blanking Risetime and Falltime: 140 ns nominal.
Vertical Drive — Output Level Into 75 Ω: 4 V ±0.5 V. Risetime and Falltime: 140 ns nominal. Duration: 9 lines.
Horizontal Drive — Output Level Into 75 Ω: 4 V ±0.5 V. Risetime and Falltime: 140 ns nominal. Duration: 6.35 μs.
Burst Gate — Output Level Into 75 Ω: 4 V ±0.5 V. Delay from Line Sync: 5.1 μs ±0.1 μs. Risetime and Falltime: 140 ns nominal. Duration: 2.5 μs ±100 ns.
Subcarrier — Output Level Into 75 Ω: 2 V. Frequency: 3.579545 MHz ±10 Hz.
Black Burst — Sync Amplitude Into 75 Ω: 40 IRE. Burst Amplitude: 40 IRE (286 mV p-p). Burst Frequency: 3.579545 MHz ±10 Hz.
Gen-Lock Signal Loop Input — Composite Video Input Range: 0.5 V to 1 V when loop-through connectors are externally terminated into 75 Ω. Comp Sync: 1 to 4 V, ref subcarrier 1.5 to 2 V p-p.

TEST SIGNAL OUTPUTS (1470)

Test Signal Generator Outputs Composite Video — Return Loss: ⩾30 dB to 5 MHz. Output Level Into 75 Ω: 1 V. Sync: 40 IRE, ±1 IRE (286 mV nominal amplitude). Peak Video Level: 100 IRE, ±2 IRE (714 mV nominal amplitude). Blanking Dc Level: 0 V, ±50 mV.
NTSC Color Bars — Full Field: 75% amplitude, 100 IRE white reference, 7.5% setup. Luminance Signal Accuracy: Within 2%. Chrominance Signal Absolute Amplitudes: Within 3% (all subcarrier frequency components).
Window Amplitude — 100 IRE, ±2 IRE. Duration: 25.8 μs, ±3%. Starts at line 66 in each field and ends at 218 in each field. Risetime: 150 ns nominal.
Crosshatch Pattern or Dots — Setup: 7.5 IRE ± 1 IRE. Peak Level: 77 IRE ±2 IRE. Risetime and Falltime: 150 ns nominal.
Multiburst — White Reference Amplitude: 100 IRE ±2 IRE. Multiburst Amplitude: 50 IRE ±2 IRE. Average Level: 55 IRE ±1 IRE. Multiburst Frequencies: 0.5 MHz, 1.5 MHz, 2.0 MHz, 3.0 MHz, 3.58 MHz, 4.2 MHz.
Staircase Luminance Component — Five Step Amplitude (each step): 20 IRE ±1 IRE (143 mV). Staircase Amplitude: 100 IRE ±2 IRE (714 mV). Aberrations: Within 2% of step amplitude. Step Risetime: 150 ns nominal.
Staircase Subcarrier Chrominance Component — Amplitude: 40 IRE ±1 IRE (286 mV p-p). Phase: 180°. Differential Phase: ⩽0.3°. Differential Gain: ⩽0.5%. Subcarrier Envelope Risetime: 400 ns nominal.

OTHER CHARACTERISTICS

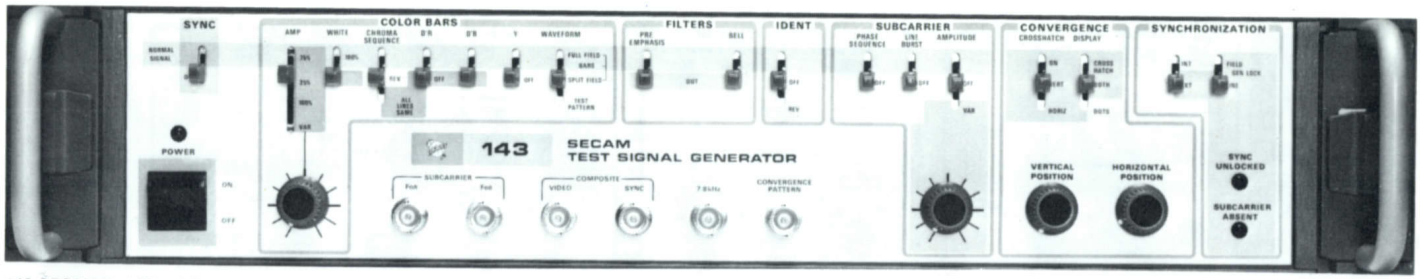
1470 Power Requirements — 115 V or 240 V line voltage, high-low ranges. Selection switches for line voltages and ranges are accessible internally. Factory set to 120 V. 120 V Range: High, 108 V to 132 V; Low, 95 V to 110 V. 240 Range: High, 216 V to 250 V; Low, 198 V to 242 V. Line Frequency: 50 to 60 Hz. Power Maximum: 50 W. 1474 Power Requirements: 115 V: 90 to 130 V. 240 V: 198 V to 250 V. Power: Maximum 40 W.

PHYSICAL CHARACTERISTICS

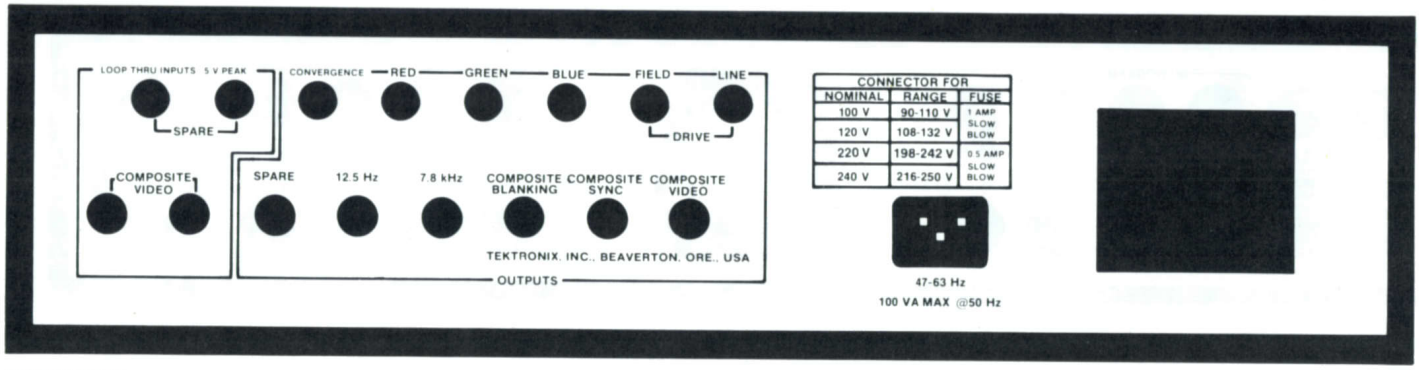
Dimensions	1470		1474	
	mm	in	mm	in
Width	483	19.0	483	19.0
Height	89	3.5	44	1.7
Depth	483	19.0	483	19.0
Weights	**kg**	**lb**	**kg**	**lb**
Net	4.9	10.8	4.2	9.2
Shipping	7.8	17.2	8.1	17.9

ORDERING INFORMATION

1470 Color Sync and Test Signal Generator (Rackmount) **$3,595**
Option 01 — Sync Generator Without Gen-Lock ..... **−$245**
1474 Color Sync Generator (Rackmount) **$2,095**
Option 01 — Sync Generator Without Gen-Lock ..... **−$245**



143 SECAM Test Signal Generator rackmount version



143 Rear Panel

143

Broadcast-Quality Gen-Lock Sync and Test Signal Generator

Composite Color Bars, Convergence Patterns, and RGB Color Bar Signals

Provisions to Modify Test Signal Components

The Tektronix 143 SECAM Test Signal Generator provides all the test, sync, and drive signals required to align and maintain SECAM television equipment. You can easily control all test signal components and synchronization modes from the front panel. Easy-to-change internal programming provides additional test signal capability to satisfy your unique testing requirements.

Test signals provided by the 143 are fully-encoded color bars, convergence pattern, and RGB color bar signals. You can select color bars in either a full-field or split-field configuration. Amplitude, white level, and chroma sequence can be changed from the front panel. You can also switch off the D'R, D'B and Y signal components individually using front panel controls.

The convergence pattern consists of movable vertical and horizontal lines plus dots. All three signals are available in any combination. A 7 x 9 or 14 x 17 crosshatch pattern may be internally selected.

RGB color bars signals are available from three separate rear-panel outputs at all times and are independent of the position of the front panel controls.

The 143 may be operated from its own internal standards or gen-locked to a SECAM composite video signal. Color lock may be referenced to either the vertical identification signals or the line burst. Front panel LEDs indicate the gen-lock status.

Additional outputs provide useful auxiliary signals including line and field drive, line and field blanking, composite sync, and two specialized output signals. These two signals are a 12.5 Hz squarewave (for identification of the SECAM four field sequence), and a 7.8 kHz squarewave (for synchronizing a waveform monitor to view either D'B or D'R lines only, while the 143 is generating a complete test signal). As a special convenience, the two unmodulated carrier (rest) frequencies are brought out to the front panel. It's easy to verify 143 calibration whenever routine maintenance or recalibration is performed.

CHARACTERISTICS

GEN-LOCK

Sync Source — Nominal 1 V composite video. Input configuration 75 Ω loop-through. Return Loss: ⩾46 dB to 5 MHz.

Sync Amplitude — 300 mV, within 10 dB.

Sync Acquisition Time — <0.6 s.

D'R'D'B Acquisition Time — Line: <100 lines (referenced to line burst). Field: <300 ms (referenced to field identification signals).

COMPOSITE VIDEO

Outputs — Full-field or split-field color bars or test pattern.

Risetime of Subcarrier Envelope at Blanking — 400 ns ±100 ns.

Bell Filter — Center Frequency: 4.286 MHz ±20 kHz. Response: ±0.5 dB of theoretical (subcarrier ⩾ −20 dB referenced to nominal amplitude). Off: Response flat ±0.5 dB 3.9 MHz to 4.75 MHz.

Chrominance/Luminance Timing — Within ±50 ns (based on red-blue transition of the D'R line).

Luminance Risetime — 100 ns ±10 ns.

Color Bar Signal Subcarrier Tolerance — Frequency: ±(1.3% of deviation + 1 kHz). Amplitude: D'B line burst 166.7 mV ±10% (subcarrier amplitude at other frequencies, relative to D'B line burst, determined by Bell filter tolerance). Variable: ≈6 dB to −54 dB relative to nominal amplitude.

Color Bar Signal Luminance Tolerance — Amplitude: ±1% or 1.5 mV, whichever is greater.

NONENCODED OUTPUT

RGB Amplitude — 525 mV ±1% (except white, 700 mV).

RGB Sync — 300 mV ±2% green only (delete by moving internal jumper).

RGB Return Loss — ⩾36 dB to 6 MHz.

CONVERGENCE

Pedestal — 0 V.

Peak Luminance Level — 525 mV ±5%.

Displays — Vertical lines, horizontal lines, dots or any combination of the preceding.

AC POWER

Mains Voltage Range — 100 V: 90 to 110 V ac. 120 V: 108 to 132 V ac. 220 V: 198 to 242 V ac. 240 V: 216 to 250 V ac.

Maximum Power Consumption — 100 W.

Mains Frequency Range — 48 Hz to 62 Hz.

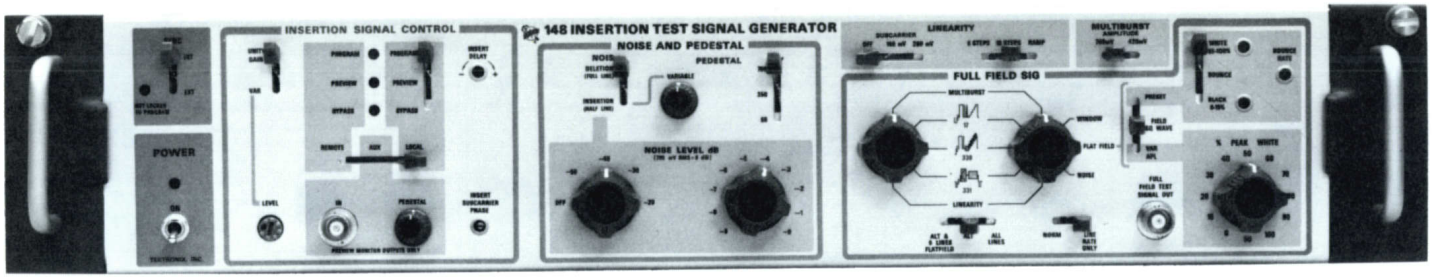
PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	420	16.8	483	19.0
Height	89	3.5	89	3.5
Depth	471	18.5	471	18.5
Weights	**kg**	**lb**	**kg**	**lb**
Net	9.1	20.0	9.3	20.5

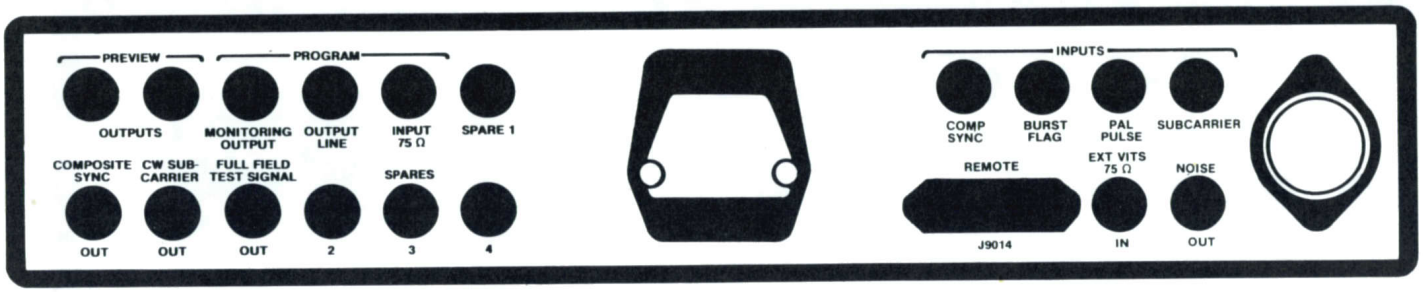
ORDERING INFORMATION

143 SECAM Test Signal Generator (Cabinet) **$10,420**

R143 SECAM Test Signal Generator (Rackmount) **$10,420**



R148 PAL Test Signal Generator



R148 Rear Panel

148/148-M

Insertion Test Signals (Per EBU, CCIR Recommendation 473-2, Annex 1)

Full-Field Test Signals (Per CCIR Recommendation 567)

Easily Reprogrammable

Safe In-Service ITS Insertion (Per EBU Specifications)

Noise Measurement

APL Bounce Signal

Source Identification Code

Operates with Sound In Syncs

Locks with Mixed Sync (Per EBU Homologation Specifications for ITS Generators) Subcarrier, PAL Pulse, Burst Flag, Comp Sync

The Tektronix 148 (PAL) and 148-M (PAL-M) Insertion Test Signal (ITS) Generators provide all the test signals you need to test and measure PAL (or PAL-M) video transmission systems. Test signals are available as both full-field composite video and ITS inserted into the incoming program signal's vertical blanking interval. All timing information for ITS insertion is derived from the incoming composite video signal.

VERTICAL INTERVAL INSERTION/ DELETION AND PROGRAM CONTROL

The 148 and 148-M insert ITS only when genlocked to an incoming composite video signal. Since ITS insertion/deletion involves active circuit elements in the program line, program line fail safe operation is provided in the event of instrument malfunction, loss of sync, or power failure. You also have access to local and remote control manual override capability.

A preview monitor output permits observation of the ITS deletion/insertion program before anything is actually done to the program signal. Preview/program operation can be locally or remotely controlled.

Provisions are made for adding an externally generated ITS to the program line.

INSERTION SIGNAL CONTROL FEATURES

Free Running Operation

A warning light indicates absence of incoming synchronizing information and ITS deletion and insertion is automatically discontinued.

Program Level

A front panel switch lets you select a preset gain, normally adjusted for unity gain between program input and program output. Or, you can use a front panel level adjustment to normalize the incoming program signal to provide 1 volt at the program output.

Local-Remote Control of Program and Preview

You can shift control of program or preview modes from the front panel (local) to a position remote from the generator. When operating under either local or remote control, front panel lights indicate program line status, since the front panel program status switch position may not correspond to the operating mode selected.

Program-Preview-Bypass

This three-position switch is used to select one of three modes: Program, Preview, or Bypass.

Program: In this switch position, ITS is inserted on program line output according to internal selection of test signals and their time addresses.

Preview: In this switch position, ITS is inserted only on program, as viewed on the preview monitor output. Preview is used for verification prior to inserting these signals on program output.

Bypass: In this switch position, incoming program material bypasses 148 functions and output is unchanged.

Auxiliary

A noncomposite video signal (such as a sweep generator) applied to the auxiliary input appears at the preview monitor output connector with composite blanking and sync added. A pedestal control provides a dc offset so the auxiliary signal excursion may be positioned between the black and white limits of the resulting composite video signal. Remote control is not available.

ITS Subcarrier Phase

A recessed front-panel control adjusts phase of color subcarrier on internally generated signals to be correct in relation to the phase of incoming burst.

Insertion Delay

A recessed front-panel control provides a fine horizontal timing adjustment for inserted signals.

TEST SIGNALS

The 148 provides the following PAL Insertion Test Signals which meet CCIR recommendation 569, 473-2, Annex 1. (These signals are also available full field):

Line 17
Line 330
Line 331

The 148 also provides these PAL Full Field Test Signals:

Field Squarewave
Flat Field
Linearity
Multiburst
Noise Measurement
Window

The 148-M provides these PAL-M Insertion Test Signals which are also available full field:

CCIR-I (Recommendation 473-2, Annex I)
CCIR-II (Recommendation 473-2, Annex II)
SIG-III (CCIR recommendation 567, Figure 27)

The 148-M also provides these PAL-M Full Field Test Signals:

Field Rate Sweep
Field Squarewave
Flat Field
Linearity
Modulated Pulse and Bar
Window

FULL-FIELD OPERATION

The Tektronix 148 and 148-M provide full-field test signals separate from program. These signals are generated with or without external synchronizing information and will be locked to the external synchronizing signal when a program signal or external synchronizing signals are present.

FLAT-FIELD SIGNAL

The flat-field signal with VITS inserted is used primarily for system testing at discrete average picture levels.

The flat-field signal is a composite video signal that, during the active portion of each field, has a constant luminance level. The luminance level is selectable in eleven increments from 0 to 100% of white. An alternate selection provides automatic change between black and white with a period variable form 1 to 10 s.

When operating the 148 in the flat field mode, you may select a white level preset between 85 and 100% and a black level preset between 0 and 15%. Automatic change between white and black is available and occurs at a period adjustable from 1.0 s to 10.0 s.

FIELD SQUAREWAVE SIGNAL

The field squarewave signal is used to measure field time distortions. In this mode, the Tektronix 148 provides a composite video signal with 205 active lines at 700 mV, approximating a 50 Hz squarewave. The 148-M provides a composite video signal with 132 active lines at 700 mV, approximating a 60 Hz squarewave.

Use this signal to detect low frequency phase and gain distortions, even those passing through clamper amplifiers.

LINEARITY SIGNAL

You can select three Linearity Test Signals: 5 step, 10 step, or ramp (either modulated or unmodulated). The subcarrier component is phase-locked to color burst. Use this signal for measuring differential gain and phase, dynamic gain, luminance signal linearity, luminance signal distortion caused by chrominance signal nonlinearity, and burst phase and amplitude errors.

WINDOW SIGNAL

The window signal in the 148 consists of a modulated 20T pulse followed by a 2T pulse followed by a bar with 2T risetime. The bar portion of the signal occupies the center 205 lines of each field. The window signal in the 148-M consists of a 2T pulse followed by a bar with a 2T risetime. The bar portion of the signal occupies the center 152 lines of each field.

MULTIBURST SIGNAL (148 ONLY)

The multiburst signal is generated by a function generator controlled by a digital programmer. This design eliminates the need for individual start/stop oscillators on each burst and individual amplitude and ac axis adjustments. Each burst start time is completely stable, and each burst packet consists of an exact number of cycles, regardless of the frequency. Each burst starts at 0° of the first cycle and ends at 360° of the last cycle. Location of the white flag with relation to the bursts is programmable and may be used for source identification.

NOISE SIGNAL (148 ONLY)

When the noise signal is selected the active picture lines contain noise generated by an internal calibrated noise source.

FIELD RATE SWEEP (148-M ONLY)

This signal consists of a sinewave that is swept in frequency from about 200 kHz to more than 6 MHz during each field period. Markers are spaced at about 1 MHz intervals. Composite sync and blanking are added to make the signal compatible with clamp circuits.

MOD PULSE AND BAR (148-M ONLY)

This signal consists of a 12.5T modulated pulse and a modulated bar with 12.5T rise and falltimes.

CHARACTERISTICS

PROGRAM CHANNEL

Input Level — Adjusted to unity gain.

Variable Input Level — ±30%.

Inserted Signal Level — Within ±1% of nominal.

Output Dc Level — <50 mV (no signal).

Frequency Response, Program, and Preview Channels — ±1%, 50 kHz to 5 MHz.

Field Time Tilt — <0.5%.

Line Time Tilt — <0.25%.

Differential Phase Standard Input — Program Output: <0.15°. Preview Output: <0.3°.

Differential Gain Standard Input — Program Output: <0.2%. Preview Output: <0.4%.

Random Noise Output Program Channel — <−75 dB RMS.

Hum, Transients on Noninserted Lines — ⩾60 dB down.

Spurious Signals During Blanking Time — Inactive line time ⩾40 dB down. Active ITS lines ⩾60 dB.

Signal Attenuation in "Delete" Mode — 2T Pulse: >−70 dB. Subcarrier (Color Bars): >−60 dB.

Crosstalk into Program Channel from Internal Signals — 2T Pulse: <−70 dB. Subcarrier (Color Bars): <−60 dB.

Unwanted Pedestal at Time of ITS Insertion — Program and Preview Channel: <5 mV.

Insert Delay Adjustment Range — ±0.5 μs front panel.

SOURCE IDENTIFICATION CODE (148 ONLY)

The Tektronix 148 is a source identification code generator with up to 25 pulses available in any combination on Line 16 or 329.

Pulse Width — 1 μs.

One Level — 630 to 700 mV above blanking.

Zero Level — Within 25 mV of blanking.

OTHER CHARACTERISTICS

Power Requirements — 90 to 136 V ac or 180 to 272 V ac; 48 Hz to 66 Hz, 55 W maximum at 115 V ac and 60 Hz. Factory set at 230 V ac (R148) or 115 V ac (R148-M).

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	463	18.2	483	19.0
Height	97	3.8	88	3.5
Depth	485	19.1	499	19.7
Weights	**kg**	**lb**	**kg**	**lb**
Net Weight	8.6	19.0	9.1	20.0
Shipping Weight ≈	15.9	35.0	16.3	36.0

INCLUDED ACCESSORIES

75 Ω BNC termination (011-0103-02); 2 each BNC-T adaptors (103-0030-00); R148 and R148-M includes rackmounting hardware (351-0195-01); manual.

ORDERING INFORMATION

148 PAL Test Signal Generator **$6,450**
R148 PAL Test Signal Generator (Rackmount) **$6,450**
148-M PAL-M Test Signal Generator .. **$8,700**
R148M PAL-M Test Signal Generator (Rackmount) **$8,700**

OPTIONAL ACCESSORIES

Noise Measurement Filters — External filters are required with the 148 Generator when making noise measurements.

Low Pass 6.0 MHz 625/50 — Order 015-0220-00 ..... **$100**

Noise Weighting 5.0 MHz 625/50 — Order 015-0215-00 . **$80**

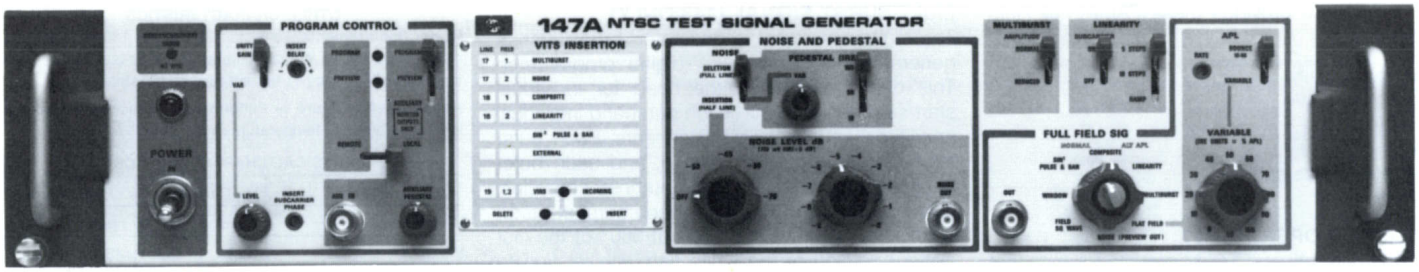
Low Pass 4.2 MHz 525/60 — Order 015-0212-00 ..... **$125**

Noise Weighting 4.2 MHz 525/60 — Order 015-0214-00 ..... **$90**

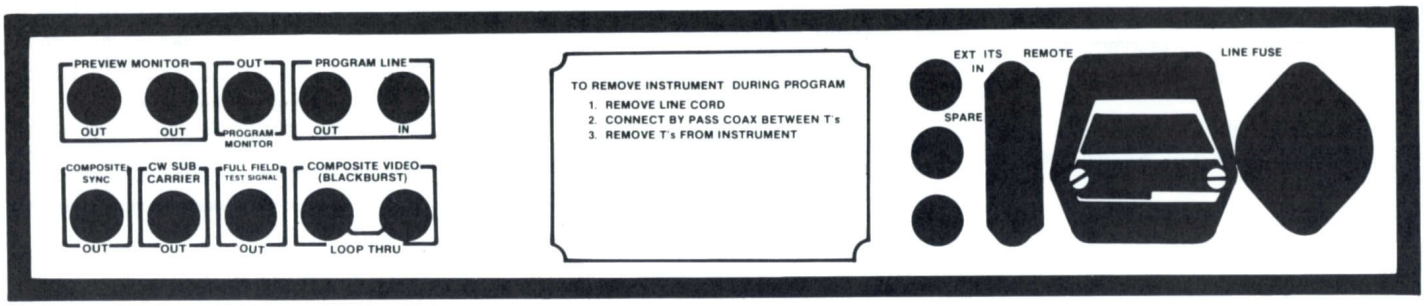
CCIR recommendation 568 provides for measuring signal-to-weighted random noise on all international transmissions (both 525/60 and 625/50) with a 5.0 MHz low pass filter and a unified noise weighting filter.

Low Pass 5.0 MHz — Order 015-0213-00 ..... **$125**

Unified Noise Weighting Network — Order 015-0283-00 ..... **$65**



R147A NTSC Test Signal Generator



R147A Rear Panel

147A

VITS Generation, Insertion, and Deletion

Sync and Burst Regeneration

Program Signal Protected

Full Field Test Signals Independently Selectable from VITS Program

Reprogrammable for New Signals

Vertical Interval Reference Signal

Noise Test Signal and Measurements

The 147A NTSC Television Signal Generator provides the test signals commonly used for test and measurement of video transmission systems. The signals generated are available as full-field composite video test signals and Vertical Interval Test Signals (VITS) that may be inserted on an incoming composite video signal.

VERTICAL INTERVAL INSERTION/ DELETION AND PROGRAM CONTROL

The 147A will insert VITS only when gen-locked to an incoming composite video signal. A VITS deleter/inserter involves active circuit elements in the program line within the generator. Fail-safe provisions are provided in the event of a malfunction within the instrument, including loss of sync or power. Local and remote-control manual override capability is also provided.

When an incoming program is lost, the 147A will go to one of two operating modes selectable by internal reprogramming jumpers. They are: program line bypass, or full-field test signal or flat-field signal. In the event the program signal is lost, the transmitter will continue on the air.

PROGRAM CONTROL FEATURES

Processing Amplifier

In addition to performing deletion and insertion functions, the 147A generator is designed to function as a sync and burst regeneration amplifier.

TEST SIGNALS

The 147A provides the following NTSC Vertical Interval Test signals. These signals are also available full field (except VIRS):

Composite
Linearity
Multiburst
Noise
Pulse and Bar
VIRS

The 147A also provides these full field test signals:

Field Squarewave
Flat Field
Window

NOISE TEST SIGNAL

The 147A offers a signal-to-noise measuring technique for in-service testing during the vertical interval. The noise present in the middle portion of a line is deleted while the noise generated in a calibrated source is inserted for measurements by comparison. You then adjust the calibrated attenuator until inserted and incoming noise appears the same on a waveform monitor. The measured noise values are independent of operator interpretation errors to within 2 IRE.

CHARACTERISTICS

PROGRAM CONTROL SYSTEM

Input Level — Adjusted to unity gain.

Variable Input level — ±30%.

Input Return Loss — >46 dB to 5 MHz. Power on, 40 dB to 5 MHz in bypass.

Inserted Signal Level — 714 mV (100 IRE) ±1%.

Frequency Reponse, Program, and Preview Channel — ±1%, 50 kHz to 5 MHz; +1%, −5%, 5 MHz to 8 MHz.

2T Pulse to Bar Ratio — 100% ±0.5%.

OTHER CHARACTERISTICS

Power Requirements — 90 to 136 V ac or 180 to 272 V ac, 48 Hz to 66 Hz, 40 W maximum at 115 V ac and 60 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	Cabinet		Rackmount	
	mm	in	mm	in
Width	455	17.9	483	19.0
Height	99	3.9	89	3.5
Depth	436	17.9	436	17.9
Weights	**kg**	**lb**	**kg**	**lb**
Net	8.9	19.0	9.1	20.0
Domestic Shipping	15.9	35.0	16.3	36.0
Export Shipping	25.0	55.0	25.4	56.0

147A OPTION 01

The 147A Option 01 provides the signals used for transmitter remote control, but Color Bars must be provided from an alternate source such as the Tektronix earlier models 140, 144, 146, or the current model 1410, SPG2, TSG7.

INCLUDED ACCESSORIES

75 Ω, BNC termination (011-0103-02); 2 each BNC-T adaptors (103-0030-00); front panel protective cover (200-1246-00); R147A rackmount slide (351-0195-01); manual.

ORDERING INFORMATION

147A NTSC Signal Generator **$9,750**

Option 01 — NTSC Signal Generator ..... **NC**

R147A NTSC Signal Generator (Rackmount) **$9,750**

Option 01 — NTSC Signal Generator (Rackmount) ..... **NC**

OPTIONAL ACCESSORIES

Noise Measurement Filters — External filters are required with the 147A Generator when making noise measurements.

Low Pass 4.2 MHz 525/60 — Order 015-0212-00 ..... **$125**

Noise Weighting 4.2 MHz 525/60 — Order 015-0214-00 . **$90**

CCIR recommendation 568 provides for measuring signal-to-weighted random noise on all international transmissions (both 525/60 and 625/50) with a 5.0 MHz low pass filter and a unified noise weighting filter.

Low Pass 5 MHz — Order 015-0213-00 ..... **$125**

Unified Noise Weighting Order 015-0283-00 ..... **$65**

1430 Random Noise Measurement Set Front Panel

1430

Conforms to CCIR Recommendation 568

In-Service Testing

Out-of-Service Testing

Program Material Protected by Fail-Safe Provisions

525/60 or 625/50 Standards

The 1430 provides random noise measurement capabilities on an in-service basis using the spatially adjacent noise matching technique with a waveform monitor. A program channel allows deletion of VITS and/or noise on selected lines in the vertical blanking interval and a monitor channel is provided for making measurements in conjunction with a waveform monitor.

The 1430 has two sections. One section, permanently mounted in the rack, contains inputs and outputs and program protecting material. The second section, containing circuitry and controls, may be easily removed without cable disconnection.

Monitor Channel

The monitor channel has an output independent from program for waveform comparison of the noise on the incoming signal and noise from the internal noise generator. Front-panel controls determine monitor channel parameters with three operating modes: VITS, Full Field, and Out of Service.

In the VITS mode, any line between 10 and 21 in either or both fields may be selected for insertion of the reference noise. The Full Field mode provides insertion on all active lines.

The Out of Service mode is provided for measurements on sources that do not have composite sync. In particular, these include transmission circuits not carrying signals at the time testing is conducted. Horizontal sync is added for waveform monitor synchronization.

In all modes the insertion width is internally set at 26 μs. Delay between insertion and sync is controlled by the Delay adjustment. A switch and a potentiometer covering a range of 0 to 100 IRE controls the insertion pedestal level.

Monitor channel gain control, with a ±3 dB range, allows nomalizing the signal for a 1 V peak-to-peak signal so that noise measurement relative to 1 V may be made. The internal noise weighting filter may be switched in or out from the front panel for evaluation of the spectral content of the incoming noise. This filter is the monitor channel only and does not affect the program output.

The 1430 may be used on both 625/50 and 525/60 systems but is shipped equipped for 525/60. The 1430 Option 01 is equipped for 625/50. Both models use the unified weighting filter per CCIR Recommendation 568. Insertion loss characteristics are as follows:

Insertion Loss ≈	
1 MHz	5.9 dB
2 MHz	10.2 dB
3 MHz	12.0 dB
4 MHz	13.0 dB
5 MHz	13.6 dB

Program Channel

The Program Channel has a 75 Ω input impedance and unity gain and output impedance of 75 Ω. No program impairment is introduced. A relay provides program signal continuity if the 1430 loses power. Internal programming, readily changeable, controls all deletion parameters. Up to three lines between 10 and 21 in either or both fields may be deleted. The deletion may be varied between the first half, second half, or full active portion of the video line. A pedestal may be inserted in the deleted portion of a line at 10, 50, or 100 IRE levels.

CHARACTERISTICS

PROGRAM CHANNEL

Signal Input Level — 1 V nominal.

Input Impedance — 75 Ω nominal.

Input Return Loss — Power On: ≥46 dB to 5 MHz. Power Off or Bypass: ≥40 dB to 5 MHz.

Output Impedance (Operating) — 75 Ω nominal.

Output Return Loss (All) — ≥30 db to 5 MHz.

Output Blanking, Dc Level — 0 V within 50 mV, for blanking pulses.

Inserted Pedestal Level — Adjustable to 100, 50, 10, or 0 IRE.

2T Pulse to Bar Amplitude — Within 0.25%.

Mod Sin² Pulse (Chrominance and Luminance) — 100% within 0.5%.

Waveform, Tilt — Field Rate Squarewave ≤0.5%, 26 μs Bar, ≤0.5%.

Differential Phase (10% to 90% APL, Standard Input) — Program Output: ≤0.15°.

Differential Gain (10% to 90% APL, Standard Input) — Program Output: ≤0.2%.

Line Time Amplitude Nonlinearity (10% to 90% APL, Standard Input) — ≤0.5%.

Random Noise — Program Output: ≥75 dB (RMS) down (using weighting and low pass filters, 5 MHz).

Hum or Transients on Noninserted Lines — ≥60 dB down, (using weighted and low pass filters, 5 MHz).

Spurious Signals During Blanking Lines — ≥40 dB down, low pass (5 MHz).

Signal Attenuation in Delete Mode — 2T pulse: ≥70 dB down. Subcarrier (Color Bars): ≥60 dB down. Insertion pedestal: 10, 50, and 100 IRE, first half, second half, or entire line (up to 3; 10 to 21) or full field.

Unwanted Pedestal at Time of VITS Insertion — ≤0.7 IRE.

Time Jitter — ≤5 ns.

NOISE

Pedestal Level — Pedestal Amplitude: 10 IRE, 50 IRE, and 100 IRE.

Pedestal Position (Insertion Mode Only) — Delay: 10 μs to 50 μs.

Noise Amplitude — 20 dB to −59.5 dB (0 dB = 700 mV RMS).

Noise Attenuators — Absolute Amplitude: Within 1 dB.

Noise Spectrum — Energy/Unit Bandwidth: Flat within 6 dB, 15 kHz to 5 MHz.

Output Impedance — 75 Ω nominal.

Output Return Loss — ≥30 dB.

Noise Weighting and Low Pass Filter — Per CCIR recommendation 421-2.

AC POWER

Line Voltage Range — 115 V ac: 90 V to 132 V. 230 V ac: 180 V to 264 V. Standard 1430: Factory set at 115 V ac. 1430 Option 01: Factory set at 230 V ac.

Maximum Line Current — 0.25 A.

Maximum Power Consumption — 30 W.

Line Frequency Range — 48 Hz to 66 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	44	1.7
Depth	429	16.9
Weights	**kg**	**lb**
Net	4.5	10.0
Shipping	7.2	16.0

INCLUDED ACCESSORIES

One pair slide guide (351-0331-03); cover program front panel (200-1481-00); manual.

ORDERING INFORMATION

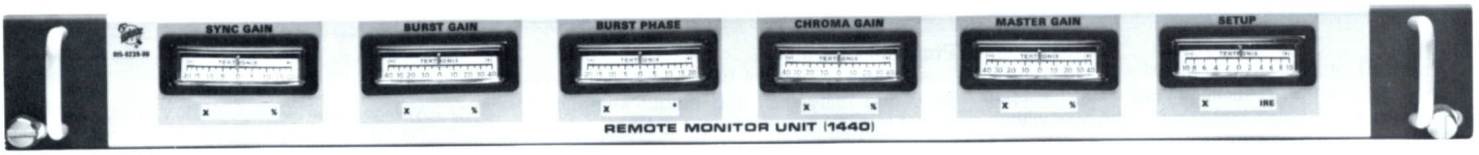
1430 Random Noise Measuring Set (525/60) **$4,115**

Option 01 — Random Noise Measuring Set (625/50) ..... **+$85**

The 1430 and 1430 Option 01 are provided with the 5.0 MHz low pass filter and unified weighting filter per CCIR Recommendation 568.

1440 NTSC Automatic Video Corrector

Remote Control Unit



Remote Monitor Unit

1440

Reduces Operating Costs

Extends Transmitter Tube Life and Reduces Maintenance Costs

Maintains Consistent High Quality Color Pictures

Automates Transmitter Modulation Level Control

Maintains Correct Sync-To-Video Ratios During Line Voltage Fluctuations

Automatic VIRS Referenced Correction of:
- **Overall Video Signal Amplitude**
- **Chrominance to Luminance Gain Ratio**
- **Black Level**
- **Chrominance Phase**
- **Burst Gain**
- **Sync Gain**

Optional Closed Loop Capabilities for Greater Efficiency and Economy in Transmitter and VTR Operations

The 1440 VIRS Automatic Video Corrector gives fully automatic correction of video gain, chrominance to luminance gain ratio, black level (set up), chroma phase, burst amplitude, and sync amplitude errors. With this corrector in your facility, the quality of the program signal is rigidly maintained. Ordinary changes and even many severe distortions are automatically corrected.

Video gain correction is referenced to the 50 IRE level of the VIRS. Chrominance to luminance gain ratio and burst phase corrections are referenced to the amplitude and phase of the VIRS chrominance respectively. Set up level correction is referenced to the 7.5 IRE level of the VIRS. Sync and burst gain corrections are controlled respective to their standard amplitudes.

Auxiliary Units

In most applications, the usefulness of automatic correction is enhanced by a Tektronix Remote Control Unit. You can conveniently select corrector modes and manually correct six signal parameters with this unit. The remote unit allows easy adjustment of the parameter's preset values for operation in the absence of a reference signal. Automatic correction value adjustments are also provided.

The Tektronix Remote Monitoring Unit provides meter indications of the amount of correction applied to the signal.

CHARACTERISTICS

Input Impedance — 75 Ω nominal.

Video Delay — 145 ns.

Output Impedance — 75 Ω.

Linear Waveform Distortions (Maximum) — Field Time: 0.5%, Line Time: 0.5%. Short Time: T Pulse/Bar: 2%. 2T Pulse/Bar: 1%.

Nonlinear Waveform Distortions — Differential Gain (10% to 90% APL): 0.5%. Differential Phase (10% to 90% APL): 0.5%. Dynamic Gain (10% to 90% APL): Picture 0.5%, sync 0.5%. Chrominance/Luminance Intermodulation: 0.5%. Line Time Nonlinearity: 0.5%.

Unweighted Video Signal to Random Noise Ratio — ⩾60 dB to 5 MHz.

Spurious Subcarrier — −60 dB.

Field Time Tilt Correction — 25% Tilt on Input Signal: Will be reduced to ⩽1%.

Clamping Characteristics — 10% to 90% APL or 90% to 10% APL. Recovery within one line to within five IRE without overshoot. Slow clamp option provided to reduce keyboarding when used with noisy signals. Hum Reduction: 1 V hum on input signal can be reduced to ⩽25 mV.

Maximum Correction Ranges — Video Level at Input: ±6 dB. Sync Level at Input: ±3 dB. Chrominance/Luminance Gain: ±3 dB. Burst Level: ±6 dB Burst/Chrominance Phase: ±25°. Black Level Set Up: ±10 IRE.

Reduced Correction Ranges — Video Level: ±2 dB. Sync Level: ±3 dB. Chrominance/Luminance Gain: ±3 dB. Burst/Chrominance Phase: ±25°. Black Level Set Up: ±5 IRE.

Dc Error-Signal Output — Source Impedance: 10 kΩ. Open Circuit Voltage: 10 V for remote metering and telemetry. Six Outputs: Video gain, sync gain, burst gain, relative chroma gain, burst phase, and set up.

Chroma/Luminance Gain Correction (+3 dB to −3 dB) −2T Pulse/Bar Ratio — 110% maximum and 92% minimum. T Pulse/Bar Ratio: 125% maximum and 85% minimum. 2T Pulse Preshoot: 5% maximum. T Step Overshoot: 5% maximum. T Step Risetime: 95 ns minimum and 155 ns maximum. Chrominance/Luminance Delay: 10 ns minimum and 10 ns maximum. VIR Signal Correction Rate: 0.35 s (90% correction without overshoot).

POWER SUPPLY

Line Voltage Range — 115 V ac ±10% and 230 V ac ±10%.

Maximum Power Consumption — 35 W.

Line Frequency Range — 48 to 66 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	881	3.5
Depth	412	16.2
Weight	**kg**	**lb**
Net	7.6	16.7
Domestic Shipping	11.0	24.1
Export Shipping	16.8	37.0

ORDERING INFORMATION

1440 NTSC Automatic Video Corrector **$6,325**

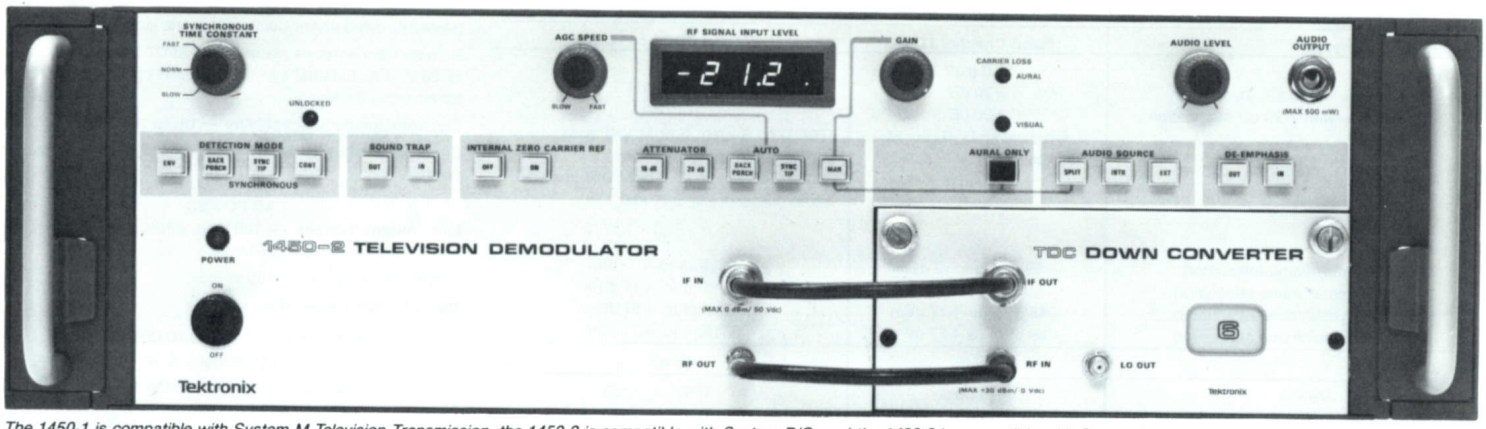
OPTIONAL ACCESSORIES

Remote Control Unit for 1440 — (Includes 2 connectors). Order 015-0240-00 ..... **$775**

Remote Monitor Unit for 1440 — (Includes 1 connector). Order 015-0239-00 ..... **$865**

Six Foot Extender Cable — With connectors for use between the 1440 and Remote Control Unit or Remote Monitor Unit. Order 012-0131-00 ..... **$300**

Three Foot Extender Cable — With connectors, for use between the 1440 chassis and the rear rackmounting section. Order 012-0137-00 ..... **$90**



The 1450-1 is compatible with System M Television Transmission, the 1450-2 is compatible with System B/G, and the 1450-3 is compatible with System I.

1450-1/1450-2/1450-3

Measurement-Quality Performance for Negligible Distortion

Synchronous Detection Elminates Quadature Distortion

Envelope Detection for Accurately Determined Differential Phase

Surface Acoustic Wave Filter Provides Precise Nyquist Slope; Excellent Long and Short-Term Stability

Digital Readout of Input Power Level for Easy, Accurate Field Strength Readings

Constant-Bandpass Characteristics Over Wide Dynamic Range

Any Single VHF or UHF Channel Operation

UHF and VHF Tunable Down Converters

Conforms to EIA Standard RS-462 (System M Only)

The 1450-1 (System M), 1450-2 (System B/G) and 1450-3 (System I) Demodulator Mainframes are combined with a Tektronix Television Down Converter (TDC) to provide an accurate link between your transmitter's RF signals and video baseband measuring equipment. Unique components work together to identify and eliminate any possible demodulation distortion in reproduced signal characteristics. You see a transparent picture of your transmitter's performance and signal output.

High Performance Spectrum Analyzers for your RF measurements are described on pages 210-225.

Tunable or Fixed-Channel Down Converters

For demodulating an RF signal at a TV channel frequency, the 1450 Series demodulator mainframes must be used with a Tektronix TDC. Three compatible TDCs are available for each system and provide a selection between tunable and fixed-channel performance. The TDC Fixed-Channel Down Converter supports your specified system channel number. Tunable Down Converters available for VHF and UHF channels are the TDC1 and TDC2 respectively.

Demodulation of the transmitter IF signal may be accomplished by using only the mainframe.

Synchronous and Envelope Detection

The 1450 Series demodulators allow you to select either synchronous or envelope detection. Each method has advantages, yet both are required for full measurement capability. For instance, synchronous detection is necessary for measurements that can be seriously affected by quadrature distortion.

The 1450 Series demodulators have two synchronous video detectors operating in phase quadrature. One detects the in-phase signal; the other detects the quadrature component of the video signal. (The quadrature component is a measure of change in visual carrier phase resulting from a change of video level.)

However, if incidental phase modulation is present on the picture carrier, the amount of differential phase measured on a synchronously detected signal will be erroneous. Because of this, an envelope detector is necessary to determine the actual differential phase present. The envelope detector has linear transfer characteristics down to 3% carrier and so provides optimum modulation depth indication.

Tektronix-Developed Surface Acoustic Wave Filter

The 1450 Series demodulators feature a SAW (surface acoustic wave) filter developed by Tektronix. It provides more precise Nyquist slope characteristics without group delay distortion, improves long- and short-term stability, and lowers maintenance costs compared to conventional filter network circuitry.

In conventional demodulators, the more precisely the bandpass characteristics approach an ideal Nyquist curve, the more complex the filter network required. In the 1450 Series demodulator mainframes however, the bandpass characteristics are determined by just a single component, the SAW filter. Precision is the result.

Conventional tuned IF circuitry must be meticulously adjusted and is subject to change with mechanical and thermal shock. But the SAW filter is in a sealed unit and accurately provides the critical selectivity characteristics of the demodulator —and requires no adjustments.

Constant-Bandpass Characteristics

The Tektronix 1450 Series demodulators offer constant-bandpass characteristics over the entire dynamic range of input signal level. Amplifiers in the mainframe operate at a constant gain, and pin-diode attenuators are used to adjust the overall gain of the demodulator. This more sophisticated approach to AGC (automatic gain control) is necessary to maintain constant-bandpass characteristics over the entire dynamic range of input power (−69 dBm to −3 dBm). Additional attenuation of 30 dB, available in 10 dB steps, can shift the range for higher input power levels. In addition to AGC, demodulator RF/IF gain control can be set for manual operation.

Digital Reading of Input Power

With the accurate (to 0.1 dB) digital readout you get measurements of input power you can depend on at transmitter sites, remote sites, or, for calibrated field strength measurements.

Split and Intercarrier Sound

For making measurements or adjustments on aural transmitters, the 1450 Series demodulators feature both split and intercarrier sound channels. The split carrier channel, which will operate without the presence of the visual carrier, may be used when making measurements on the aural transmitter only.

Four audio outputs give added measurement capability: a 600 Ω output, two low impedance outputs for driving a speaker or headphones, and a calibrated output for making deviation measurements with an AC voltmeter or an oscilloscope.

Quadrature Distortion

Quadrature distortion occurs when a single sideband signal is demodulated with an envelope detector.

Quadrature distortion most severely affects the chrominance signal, causing a loss of brightness in highly saturated colors, especially those at high luminance levels. Narrow white picture elements against the dark backgrounds are reproduced at reduced brightness.

Synchronous detection of the television RF signal elminates quadrature distortion, allowing the true performance of the transmitter to be determined.

CHARACTERISTICS

RF Characteristics	Fixed Channel TDC	Tunable TDC1 or TDC2
RF Input Impedance	50 Ω (N)*1	50 Ω (N)*1
Return Loss with 0 dB attentuation	⩾20 dB	⩾10 dB
Return Loss with ⩾20 dB attenuation	⩾30 dB	⩾30 dB
Frequency	Any System B, G, I or M assigned carrier frequency ±20 kHz	(TDC1) All System B or M VHF assigned carrier frequencies, ±27 kHz (TDC2) All System G, I, or M UHF assigned carrier frequencies, ±27 kHz
Level Range		
(0 dB from mainframe attenuator)	−69 dBm to −3 dBm	−65 dBm to +1 dBm
(10 dB from mainframe attenuator)	−59 dBm to +7 dBm	−55 dBm to +11 dBm
(20 dB from mainframe attenuator)	−49 dBm to +17 dBm	−45 dBm to +21 dBm
(30 dB from mainframe attenuator)	−39 dBm to +27 dBm	−35 dBm to +31 dBm
AGC Range	66 dB	66 dB
Noise Figure VHF	⩽10 dB	TDC1 ⩽19 dB
UHF	⩽11 dB	TDC2 ⩽19 dB
Adjacent Channel Cross Modulation	⩾60 dB	⩾60 dB
Alternate Channel Cross Modulation	⩾60 dB	⩾60 dB
Variation in Frequency Response with AGC	(VHF) ⩽±0.1 dB (UHF) ⩽±0.15 dB	System B, G, I ⩽±0.4 dB System M ⩽±0.3 dB

**1 In 50 Ω:* *+27 dBm = 5 V RMS* *+31 dBm = 8 V RMS*; *−3 dBm = 158 mV RMS* *+1 dBm = 251 mV RMS*; *−69 dBm = 80 μV RMS* *−65 dBm = 126 μV RMS*

IF

Input Impedance (Z_{in}) — 50 Ω (BNC).

Return Loss — >18 dB.

IF Level Range — −20 dBm to −64 dBm. (Signal to noise ratio deteriorates as signal level decreases.)

IF Frequency

1450-1: Visual is 37, 38.9, or 45.75 MHz ±127 kHz (as specified by the mainframe/TDC options). Aural is 4.5 MHz below visual.

1450-2: Visual is 38.9 MHz ±127 kHz. Aural is 5.5 MHz below visual.

1450-3: Visual is 38.9 MHz ±127 kHz. Aural is 6.0 MHz below visual.

VIDEO

Video Output — Z_0: 75 Ω (2 BNC). Return Loss: ⩾34 dB. Level 1 V p-p sync tip to peak white.

Dc Level — Back Porch AGC: Blanking level at 0 V ±50 mV. Sync Tip AGC: Referenced to blanking level, sync tip is at −286 mV ±5.7 mV (1450-1), −300 mV ± 6 mV (1450-2, 1450-3).

Line Time Distortion — ⩽0.5%, wideband IF, synchronous detection. 1.0% in all other IF, detection mode combinations.

Field Time Distortion — ⩽0.5%.

Line Time Nonlinearity — ⩽1%.

Differential Gain — Synchronous: ⩽1%. Envelope: ⩽4%. **Differential Phase** — ⩽1°.

Chrominance/Luminance Delay — ⩽±20 ns.

Chrominance/Aural/Visual Carrier Intermod — ⩾50 dB down.

Aural Signal Rejection — ⩾46 dB.

Video Signal to Noise Ratio — Low Frequency (p-p video/p-p hum): ⩾60 dB. Mid Frequency Coherent (p-p video/p-p noise): ⩾50 dB. White Noise (p-p video/RMS noise): ⩾60 dB.

Quadrature Output — Z_0: 75 Ω (BNC). Return Loss: ⩾34 dB. Quadrature Phase: 90° ±2° (with respect to Video Out).

Zero Carrier Reference Gate

1450-1: Width is 30 μs ±10%. Delay is 20 μs ±10% from leading edge of sync. Carrier Cutoff is ⩾50 dB. Zero Carrier is ±0.5 IRE. Timing Factory is set to line 20 of both fields, internally selectable from lines 10 through 25 of both fields.

1450-2, 1450-3: Width is 30 μs ±10%. Carrier Cutoff is ⩾50 dB. Zero Carrier is ±3.5 mV. Timing Factory Set to Line is 16/329 of both fields, internally selectable from lines 10/323 through 25/338 of both fields.

EXT Zero Carrier Reference Drive Input — Z_{in}: ≈5 kΩ (BNC). Level Required: ≈±1 V.

AUDIO

Frequency Response

1450-1: De-emphasis Out is ±0.4 dB (30 Hz to 20 kHz). De-emphasis In Standard is 75 μs. De-emphasis Curve is ±0.4 dB.

1450-2, 1450-3: De-emphasis Out is ±0.4 dB (30 Hz to 25 kHz). De-emphasis In Standard is 50 μs. De-emphasis Curve is ±0.5 dB.

Harmonic Distortion — ⩽0.2% (30 Hz to 15 kHz at full output with ±25 kHz deviation) for 1450-1 or ±50 kHz deviation for 1450-2 and 1450-3.

Audio Signal to Noise Ratio — Intercarrier Mode: ⩾55 dB. Split Carrier Mode: 1450-1, 1450-2 is ⩾75 dB. 1450-3 is ⩾70 dB. External Aural Intercarrier In: ⩾75 dB. Aural Only Mode: ⩾75 dB. All at 1 kHz modulation and ±25 kHz (±50 kHz for 1450-2 and 1450-3) deviation.

Deviation Output — Z_0: 600 Ω (BNC). Level: 50 mV/kHz ±1% (20 kHz/V ±1%).

Aural Intercarrier In — Z_{in}: 50 Ω (BNC). Return Loss: ⩾20 dB. Level: −30 dBm ±5 dB.

Aural Intercarrier Output — Z_0: 50 Ω (BNC). Return Loss: ⩾20 dB. Level Nominal: −6 dBm up to 0 dBm.

600 Ω Balance Line Output — Level +10 dBm except 1450-3 level +8 dBm (internally adjustable from ⩽−10 dBm to +15 dBm). Connector XLR.

8 Ω Speaker Output — Level up to 5 W RMS, front panel adjustable. Connector Barrier block.

Headphone Output — Level up to 50 mW into 8 Ω headphone (stereo or mono style). Connector phone jack.

Remote Connector — Alarm output SPDT relay contact rated at 28 V, 3 A. External synchronous/envelope switch. Ground for envelope detection.

Electromagnetic Susceptibility — Up to 10 V/meter.

Damage Level at RF Input — 1 W maximum (any attenuator setting).

AC POWER

Line Voltage Ranges — 100 V ac ±10%, 120 V ac ±10%, 220 V ac ±10%, 216 to 250 V ac.

Power Consumption — 100 W max.

Mains Frequency — 48 Hz to 62 Hz.

ENVIRONMENTAL CHARACTERISTICS

Temperature Range — Operating: 0°C to 50°C.

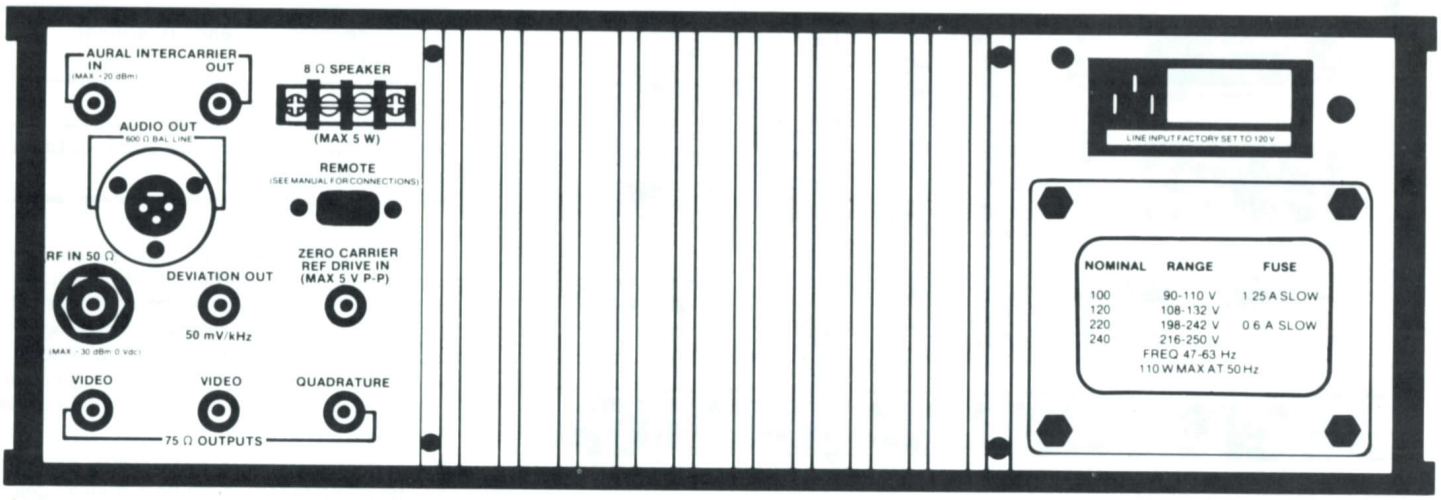
Altitude Range — Operating: Sea level to 4570 m (15,000 ft).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	133	5.25
Depth	486	19.1
Weight	**kg**	**lb**
Mainframe	16.3	36.0
Down Convertor	2.3	5.0

INCLUDED ACCESSORIES

Pair rackmount slide guide (351-0301-03); N to BNC coaxial adaptor (103-0045-00); extender circuit board (670-5034-00); 50 Ω BNC coax cable (012-0751-00); 50 Ω SMA double shield coax cable (012-0752-00); two BNC to square-pin-adaptor cables (175-2140-00); BNC to Peltola adaptor cable (067-0709-00); TORX screwdriver (003-0816-00); male connector (131-1007-00); hood (200-1170-00); two screws (213-0260-00); low pass filter (015-0352-00). For 1450-1: ICPM graticule (331-0393-12); 0.6 A slow blow fuse (159-0043-00). For 1450-2 and 1450-3: ICPM graticule (331-0393-15); 1.25 A slow blow fuse (159-0041-00). Manual.



ORDERING INFORMATION, SYSTEM M

1450-1 Television Demodulator
(Order one vision IF option) **$13,935**

Option 01 — 37 MHz Vision IF ..... **NC**
Option 02 — 38.9 MHz Vision IF ..... **NC**
Option 03 — 45.75 MHz Vision IF ..... **NC**
Option 10 — Wide Bandwidth Audio
20 Hz to 55 kHz ±0.4 dB ..... **+$165**

For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-1 mainframe.

Order one vision IF option and either Option 11 or 14.

TDC Fixed Channel Down Converter
(stiplulate channel number when ordering) **$3,445**
TDC-1 Tunable Down Converter VHF Band **$7,435**
TDC-2 Tunable Down Converter UHF Band **$7,435**
Option 01 — 37 MHz Vision IF ..... **NC**
Option 02 — 38.9 MHz Vision IF ..... **NC**
Option 03 — 45.75 MHz Vision IF ..... **NC**
Option 11 — System M Countries ..... **NC**
Option 14 — System M Countries ..... **NC**

ORDERING INFORMATION, SYSTEM B/G

1450-2 Television Demodulator
(Order both Option 02 and Option 09) . **$11,900**

Option 02 — 38.9 MHz Vision IF ..... **NC**
Option 09 — +90/−170 ns Group Delay ..... **NC**
Option 10 — Wide Bandwidth Audio
20 Hz to 55 kHz ±0.4 dB ..... **+$165**

For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-2 mainframe. Order both Option 02 and Option 12.

TDC Fixed Channel Down Converter
(stiplulate channel number when ordering) **$3,445**
TDC-1 Tunable Down Converter VHF Band **$7,435**
TDC-2 Tunable Down Converter UHF Band **$7,435**
Option 02 — 38.9 MHz Vision IF ..... **NC**
Option 12 — System B/G/I countries ..... **NC**

ORDERING INFORMATION, SYSTEM I

1450-3 Television Demodulator
(Order Option 02) **$13,145**

Option 02 — 38.9 MHz Vision IF ..... **NC**
Option 10 — Wide Bandwidth Audio
20 Hz to 55 kHz ±0.4 dB ..... **+$165**

For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-3 mainframe. Order both Option 02 and Option 12.

TDC Fixed Channel Down Converter
(stiplulate channel number when ordering) **$3,445**
TDC-1 Tunable Down Converter VHF Band **$7,435**
TDC-2 Tunable Down Converter UHF Band **$7,435**
Option 02 — 38.9 MHz Vision IF ..... **NC**
Option 12 — System B/G/I countries ..... **NC**

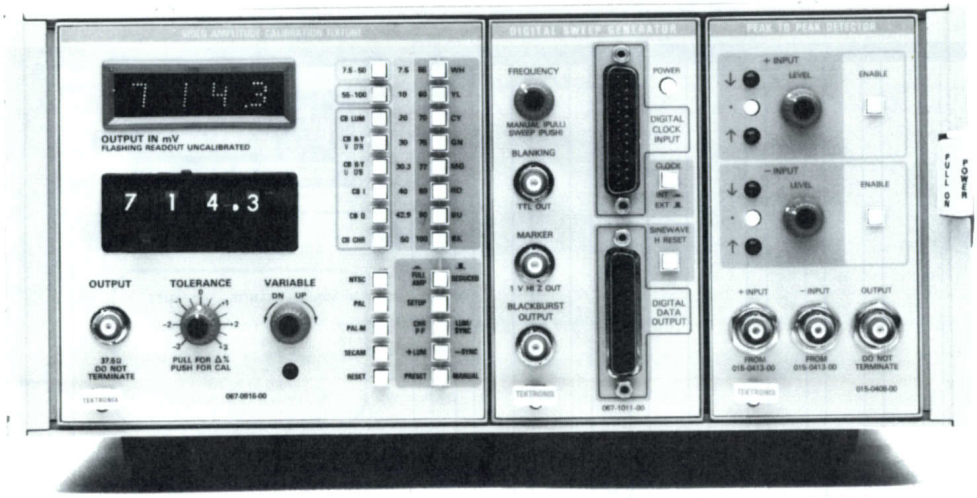
COUNTRIES: SYSTEM M (Option 11)
Antigua, Barbados, Bermuda, Brazil, Canada, Chile, Colombia, Costa Rica, Cuba, Curacao, Dominican Republic, Ecuador, El Salvador, Guam, Guatemala, Johnston Islands, Korea, Mexico, Micronesia, Netherlands Antilles, Nicaragua, Panama, Peru, Phillipines, Puerto Rico, Samoa, St. Kitts, Surinam, Taiwan, Trinidad/Tobago, Uruguay, U.S.A., Venezuela, Virgin Islands.

COUNTRIES: SYSTEM M (Option 14)
Japan and Okinawa.

COUNTRIES: SYSTEM B/G/I (Option 12)
Algeria, Austria, Bahrain, Bangladesh, Belgium*2, Brunei, Cyprus, Denmark, East Germany, Egypt, Equatorial Guinea, Ethiopia, Finland, Ghana, Gibraltar, Greece, Hong Kong, Iceland, India, Indonesia, Iran, Iraq, Israel, Ireland (UHF)*1, Italy (UHF), Jordan, Kenya, Kuwait, Lebanon, Liberia, Libya, Malta, Mauritius, Netherlands, Nigeria, Norway, Oman, Pakistan, Portugal, Qatar, Rhodesia, Saudia Arabia*2, Sierra Leone, Singapore, South Africa (UHF)*1, Spain, Sudan, Sweden, Switzerland, Syria, Tanzania, Thailand*2, Tunisia, Turkey, Uganda, United Arab Emirates, United Kingdom (UHF)*1, West Germany, Yemen Arab Republic, Republic of Yemen, Yugoslavia, Zambia.

*1 System I
*2 System B only.

TEK DIGITAL SWEEP GENERATOR, PEAK-TO-PEAK DETECTOR AND VIDEO AMPLITUDE CALIBRATION FIXTURE



Video Amplitude Calibration Fixture, Digital Sweep Generator, and P-P Detector shown in a Tektronix TM 504 Mainframe

Accurate calibration and verification of video equipment performance is essential for maintenance of optimum television system quality and thus signal quality.

New products, as well as calibration standards and procedures, have been developed to help provide accurate and NBS-traceable calibration and performance verification of Tektronix television products.

VIDEO AMPLITUDE CALIBRATION FIXTURE

Provides a Standard Reference For Amplitude Calibration

Preset Values For Common Video Signals

NTSC, PAL, PAL-M, SECAM Compatible

The VAC (Video Amplitude Calibration Fixture) is a precision test fixture used in the measurement of common video signals and the calibration of video test signal generators and waveform monitors. It provides a simple means of measuring and calibrating luminance and chrominance amplitudes associated with most video signals.

The VAC provides a squarewave amplitude reference from 0.0 mV to 999.9 mV peak with a resolution of 0.1 mV and an accuracy of 0.05%. Signal amplitude may be selected using a four-digit front panel lever-switch or from over 500 preset values stored in EPROM. The VAC preset amplitudes are compatible with NTSC, PAL, PAL-M and SECAM television systems.

In the design of the VAC, careful attention was paid to thermal tilt to ensure accurate conversion from dc calibration to squarewave output. Unique choice of output impedance compensates loading effects when calibrating equipment with loop-through inputs.

The calibration of the VAC requires only a digital voltmeter with an accuracy of 0.01%.

The VAC operates in any of two compartments of the Tektronix TM 500 or TM 5000 Series power modules (except TM 501).

CHARACTERISTICS

Output Signal

Front Output Connector — 37.5 Ω; BNC connector located on front panel.

Rear Interconnect — 0.0 Ω; Rear edge connector pins 27A and 28A.

Amplitude Range (Tolerance Disabled) — 0 mV to 999.9 mV ±(0.05% +0.1 mV); p-p squarewave amplitude.

Amplitude Range (Tolerance Enabled) — 0 mV to 999.9 mV ±(0.5% +0.1 mV) + Tolerance reading; p-p squarewave amplitude.

Resolution — 0.1 mV.

Risetime — Less than 1 μs.

Frequency — NTSC, PAL-M, 270 Hz nominal; PAL, SECAM, 275 Hz nominal.

ENVIRONMENTAL

Normal Operating Temperature — +15°C to +35°C.

Operating Temperature Range — 0°C to +50°C.

Weights — Net: 1.4 kg, (3.0 lb). Net Shipping: 4.5 kg, (10.0 lb).

INCLUDED ACCESSORIES

(±0.025%) 75 Ω Terminator (011-0102-01); 0.06% attenuator (011-0134-00); subcarrier harmonic rejection filter (015-0407-00); manual.

Order 067-0916-00 Video Amplitude Calibration Fixture **$2,250**

OPTIONAL ACCESSORIES

72 in Low Loss 75 Ω Cable — Order 012-0159-01 ..... **$30**

PEAK-TO-PEAK DETECTOR

NBS-Traceable Frequency Response Standard

Ultra Flat Response

Detector Amplifier Corrects Detector Diode Gain and Offset Errors

The 015-0408-00 Detector Amplifier, combined with a 015-0413-00 Detector Head, comprise an NBS-traceable peak-to-peak detector system for baseband video frequency response testing. This system allows precise comparison of sinewave amplitudes at frequencies throughout the video spectrum. Typical response is accurate to as low as ±0.02% (±0.002 dB).

The frequency response of an analog generator may be calibrated using the peak-to-peak detector system as a transfer standard. The generator may then be used as a frequency response transfer standard to calibrate frequency response and chrominance-luminance gain of test equipment such as waveform monitors and vectorscopes.

A second detector head may be ordered for differential measurements.

CHARACTERISTICS

Input Signal Range — 0.25 V to 1.0 V p-p.

Envelope Gain Unit — ±0.1% for 1% signal change.

Input Impedance — 75 Ω.

Frequency Response

Frequency	Performance Requirements	Supplemental Information		
		Typical Response	Transfer Uncertainties	
			TEK	NBS
25 kHz	+0.1, −0.7%	+0, −0.25%	±0.05%	±0.01%
50 kHz	+0.1, −0.3%	+0, −0.1%	±0.05%	±0.02%
100 kHz	±0.1%	±0.05%	±0.05%	±0.02%
200 kHz	±0.1%	±0.02%	±0.05%	±0.05%
500 kHz	±0.1%	±0.02%	±0.05%	±0.05%
1 MHz	0.0% (Reference)	±0.02%	±0.05%	±0.05%
2 MHz	±0.1%	±0.02%	±0.05%	±0.1%
5 MHz	±0.1%	±0.02%	±0.05%	±0.1%
10 MHz	±0.15%	±0.05%	±0.05%	±0.1%
20 MHz	±0.2%	±0.1%	±0.05%	±0.2%
30 MHz	±0.5%	±0.2%	±0.1%	±0.2%
50 MHz	±2.0%	±1.0%	±0.2%	±0.5%

INCLUDED ACCESSORIES

Detector head and data sheet with NBS-traceability curves (015-0413-00); 72 in low loss 75 Ω cable (012-0159-01); manual.

Order 015-0408-00
Peak-to-Peak Detector **$1,265**

OPTIONAL ACCESSORIES

Extra Detector Head — (for differential measurements).
Order 015-0413-00 ..... **$195**

Please have a Sales Representative contact me regarding

_____

My phone number is _____ **Ext** _____

Send me information on:

- ☐ _____ Product Applications
- ☐ Customer Training for _____ Products
- ☐ Tektronix Service Programs for _____ Products
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D740-11-AXX

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DIGITAL SWEEP GENERATOR

Digitally Derived Sweep Signal

10-Bit Digital Data For Use With 1900-Series Digital Test Signal Generators to Reconstruct Analog Sweep

Frequency Range 55.9 kHz to 7.16 MHz Field Sweep or (Manually Adjustable) CW

The Digital Sweep Generator provides 10-bit, 14.31818 MHz, digital data words derived from a cosine lookup table. The output signal sweeps from 55.9 kHz to 7.16 MHz in each field with high spectral purity and amplitude accuracy when used with the DAC in a 1900 Series generator. A front panel connector provides SMPTE*[1] compatible balanced ecl data. Data is continuous through blanking so that it can be used with noncomposite video detectors. Sync and burst may be inserted by a 1900 Series generator using the blanking output on the DSG if desired. The Digital Sweep Generator may be locked to a 1900 Series generator using TRS and clock outputs from the 1900 Series generator. Alternatively, the 1900 Series generator may be genlocked to the black burst output from the sync generator in the digital sweep generator. A separate marker output provides identification of 1 MHz intervals, as well as 3.58 MHz and 4.43 MHz, during the sweep.

The Digital Sweep Generator is enclosed in a single wide TM 500 package. The front panel includes an LED power indicator, two 25-pin digital data connectors, three BNC connectors for blanking, markers, and black burst outputs, and one variable control to manually set CW frequencies. Digital interfaces of the DSG conform to the signal levels, clock rate and pinout of the proposed SMPTE standard.

When the Digital Sweep Generator is used in conjunction with a 1900 and an 015-0408-00 peak-to-peak detector (included accessory), it will provide an NBS-traceable analog frequency response standard and completes an effort to provide NBS-traceable performance verification of Tektronix television generators, waveform monitors, and other television equipment.

*[1] *The proposed SMPTE standard "Digital Format for a Parallel Interface (System M/NTSC)." draft of July, 1979.*

CHARACTERISTICS

Digital Sweep Output

Frequency Range — 55.93 kHz to 7.159 MHz in 55.93 kHz increments; Field Sweep, or CW digital data.

Format — SMPTE Standard parallel 10-bit signal.

Sample Clock Frequency — 14.31818 MHz (4 fsc) ±100 Hz; also accepts external 14.3 MHz clock from 1900.

Blanking — Vertical: 22-23 lines. Horizontal: 10.8 μs.

Markers

1 V at 1.006747 MHz.

1 V at 2.013494 MHz.

1 V at 3.020241 MHz.

0.5 V at 3.579545 MHz.

1 V at 4.026988 MHz.

0.5 V at 4.418501 MHz.

1 V at 4.977805 MHz.

1 V at 5.984552 MHz.

Marker frequencies are multiples of 55.93 kHz.

ENVIRONMENTAL

Temperature Range — Operating: 0°C to +50°C. Nonoperating: −40°C to +65°C.

Altitude — Operating: To 4752 m (15,000 feet). Nonoperating: To 15 240 m (50,000 feet).

Weights — Net:0.6 kg (1.3 lb). Net Shipping: 1.3 kg (2.8 lb).

INCLUDED ACCESSORIES

ECL data cable assemblies (175-3671-00); 72 in low loss 75 Ω cable (012-0159-01); p-p detector (015-0408-00); manual.

Order 067-1011-00 Digital Sweep Generator **$3,310**

OPTIONAL ACCESSORIES

Detector Head Order 015-0407-00 ..... **$120**

TEST MODULATOR

High Quality Double-Sideband Modulator

Available in 5 Versions Covering Systems M, I, B, and G

RF Output is −25 dBm ±3 dB

IF Output is −24 dBm ±3 dB

Separate Video and Aural Carrier Level Controls

Group Delay Precorrection Systems M, B, and G

The 1450 Series Test Modulator is used to test a television demodulator plus down converter (system) or the television demodulator alone. Test modulators are available for four CCIR Systems and three visual IF Carrier Systems. The Test Modulator converts baseband video frequencies to a specified IF or RF. The aural carrier is below the visual carrier frequency at the IF output and above the visual carrier at the RF output.

Group delay precorrection (except System 1) and sound pre-emphasis switches are front panel mounted. The RF and IF outputs provide double-sideband modulated signals of high quality. State-of-the-art circuitry is used to achieve high accuracy and stability. The test modulator needs very little maintenance or recalibration.

ORDERING INFORMATION

Test Modulator, 37 MHz for 1450-1.
Order 067-0886-01 ..... **$4,275**
Test Modulator, 38.9 MHz for 1450-1.
Order 067-0886-02 ..... **$4,275**
Test Modulator, 45.75 MHz for 1450-1.
Order 067-0886-03 ..... **$4,275**
Test Modulator, 38.9 MHz for 1450-2.
Order 067-0886-04 ..... **$4,275**
Test Modulator, 38.9 MHz for 1450-3.
Order 067-0886-05 ..... **$4,275**
Extender Cable, for TDC/14501,-2,-3.
Order 067-0899-00 ..... **$90**

OPTIONAL ACCESSORIES

Half-Rack Adaptor Kit — (Two instruments side-by-side)
Order 020-0633-00 ..... **$70**
Half-Rack Adaptor Kit — (One instrument and a "dummy" box, side-by-side) Order 020-0634-00 ..... **$250**

Other Calibration Fixtures for Tektronix Television Products.

ORDERING INFORMATION

GENERATORS

Diagnostic Prom Order 067-0964-00 ..... **$125**

690SR PICTURE MONITOR

Minimum Load Unit Order 067-0998-00 ..... **$175**
Rigid Module Extender Order 067-0999-00 ..... **$50**
Flexible Interface Module Extender
Order 067-1000-00 ..... **$125**
CRT Scale, 11 X 15 line for 690SR, Option 40/42.
Order 067-1034-00 ..... **$150**
Pattern Generator Order 067-1039-00 ..... **$3,000**
CRT Scale, 14 X 17 line for 690SR.
Order 067-1054-00 ..... **$150**
CRT Scale, 15 X 20 line for 690 SR.
Order 067-1055-00 ..... **$150**

1980 ANSWER

Service Kit for the 1980, Order 067-1115-00 ..... **$3,000**

Tektronix Calibration Fixtures (067-XXXX-0X part numbers) are designed for calibration and verification of specific products. Some fixtures may not be supported at the same level as standard Tektronix products. Your local Tektronix Sales Office can advise you regarding availability and support.

AUTHORIZED PROFESSIONAL VIDEO DEALERS

ALABAMA
Pro Video Systems, Inc.
240 Oxmoor Circle
Suite 103
Birmingham, AL 35209
Phone: (205) 942-7904

CALIFORNIA
Broadcast Marketing Associates
2211 C Fortune Drive
San Jose, CA 95131
Phone: (408) 946-2236

California Video Sales, Inc.
4865 Pasadena Avenue
Sacramento, CA 95841
Phone: (916) 488-2737

General Electronic Systems, Inc.
1440 San Pablo Avenue
Berkeley, CA 94702
Phone: (415) 527-7700

Hoffman Video Systems
800 West Pico Blvd.
Los Angeles, CA 90015
Phone: (213) 749-3311

Merlin Engineering Works, Inc.
1880 Embarcadero Road
Palo Alto, CA 94303
Phone: (415) 856-0900

Omega Video, Inc.
14326 Isis Ave.
Lawndale, CA 90260
Phone: (213) 679-9021

R. E. Snader & Associates, Inc.
150 Gate 5 Road
Salusalito, CA 94965
Phone: (415) 332-7070

Tritronics, Inc.
2921 West Alameda Avenue
Burbank, CA 91505
Phone: (213) 843-2170

COLORADO
Ceavco Audio-Visual Co., Inc.
1650 Webster Street
Denver, CO 80215
Phone: (303) 238-6493

Video Teknix, Inc.
633 South Federal Blvd.
Denver, CO 80219
Phone: (303) 922-5564

FLORIDA
Florida Video Systems, Inc.
14422 N. W. 7th Avenue
Miami, FL 33168
Phone: (305) 688-6618

Hubbard Communications, Inc.
10383 Oak Street N. E.,
Suite 5
St. Petersburg, FL 33702
Phone: (813) 577-7759

GEORGIA
Gray Communications Consultants, Inc.
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Phone: (912) 883-2121

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EMC Corp.
550 Palea St. #103
Honolulu, HI 96819
Phone: (808) 836-1138

ILLINOIS
Roscor Corporation
6160 W. Oakton Street
Morton Grove, IL 60053
Phone: (312) 539-7700

Swiderski Electronics, Inc
1200 Greenleaf Ave.
Elk Grove Village, IL 60007
Phone: (312) 364-1900

KENTUCKY
Midwest Corporation
One Sperti Drive
Edgewood, KY 41017
Phone: (606) 331-8990

MASSACHUSETTS
Cramer Video, Inc.
120 Hampton Ave.
Needham, MA 02194
Phone: (617) 449-2100

Lake Systems Corporation
55 Chapel Street
Newton, MA 02160
Phone: (617) 244-6881

MARYLAND
Professional Products, Inc.
4964 Fairmont Ave.
Bethesda, MD 20814
Phone: (301) 657-2141

MICHIGAN
General Television Network
13225 Capital Avenue
Oak Park, MI 48237
Phone: (313) 548-2500

Thalner Electronic Labs, Inc.
7235 Jackson Road
Ann Arbor, MI 48103
Phone: (313) 761-4506

MINNESOTA
Emmons Associates, Inc.
1121 Riverwood Dr.
Burnsville, MN 55337
Phone: (612) 890-8920

Todd Communications, Inc.
6545 Cecilia Circle
Minneapolis, MN 55435
Phone: (612) 941-0556

Video Midwest, Inc.
5050 West 78th Street
Minneapolis, MN 55435
Phone: (612) 831-2248

MISSOURI
Television Engineering Corporation
580 Goddard Avenue
Chesterfield, MO 63017
Phone: (314) 532-4700

Video Masters, Inc.
P. O. Box 1963
Kansas City, MO 64141
Phone: (816) 474-8530

VMI Company
2368 Schuetz Road
St. Louis, MO 63141
Phone: (314) 569-1334

NORTH CAROLINA
Technical Video Systems, Inc.
215 North Broad Street
Winston-Salem, NC 27101
Phone: (919) 748-0916

NEW JERSEY
A. F. Associates, Inc.
100 Stonehurst Court
Northville, NJ 07647
Phone: (201) 767-1000

Landy Associates, Inc.
1890 E. Marlton Pike
Cherry Hill, NJ 08034
Phone: (609) 424-4660

Philips Television Systems, Inc.
900 Corporate Drive
Mahwah, NJ 07430
Phone: (201) 529-1550

Tele-Measurements, Inc.
145 Main Avenue
Clifton, NJ 07014
Phone: (201) 473-8822

Turner Engineering, Inc.
14 Morris Ave.
Mountain Lakes, NJ 07046
Phone: (201) 263-0023

NEW YORK
Audio-Video Corporation
213 Broadway
Menands (Albany), NY 12204
Phone: (518) 449-7213

Camera Mart Inc.
456 West 55th St
New York, NY 10019
Phone: (212) 757-6977

Laumic Co., Inc.
306 East 39th Street
New York, NY 10016
Phone: (212) 889-3300

MPCS Video Industries, Inc.
514 West 57th Street
New York, NY 10019
Phone: (212) 586-3690

Professional Electronics
1594 State Street
Woodlawn Plaza
Schenectady, NY 12304
Phone: (518) 374-1515

Reeves AV Systems, Inc.
227 East 45th Street
New York, NY 10017
Phone: (212) 573-8652

Sonocraft Corporation
360 West 31st Street
New York, NY 10001
Phone: (212) 760-9300

OHIO
Kavco Incorporated
3931 Image Drive
Dayton, OH 45414
Phone: (513) 898-2003

OKLAHOMA
Diversified Electronics Communications DELCOM
6019 S. 66th E. Ave.
Tulsa, OK 74145
Phone: (918) 494-9500

OREGON
Videosonics, Inc.
821 S. E. 14th Avenue
Portland, OR 97214
Phone: (503) 232-4632

PENNSYLVANIA
Alpha Video & Electronics Company
28 East Mall Plaza
Carnegie, PA 15106
Phone: (412) 923-2070

Electromedia, Inc.
610 Melwood Avenue
Pittsburgh, PA 15213
Phone: (412) 683-5424

Lerro Electrical Corp.
3125 N. Broad Street
Philadelphia, PA 19132
Phone: (215) 223-8200

Peirce-Phelps, Inc.
2000 N. 59th Street
Philadelphia, PA 19131
Phone: (215) 879-7171

TEXAS
Broadcast Systems Inc.
8222 Jamestown Drive
Austin, TX 78758
Phone: (512) 836-6011

Magnetic Media Corporation
4801 Keller Springs Road
Dallas, TX 75248
Phone: (214) 931-0404

MZB & Associates
4203 Beltway Drive
Dallas, TX 75234
Phone: (214) 233-5535

Video Systems, Inc.
2123 W. Governors Circle
Houston, TX 77092
Phone: (713) 686-9651

UTAH
Skaggs Video Sales
P. O. Box 27477
Salt Lake City, UT 84127
Phone: (801) 539-1420

WASHINGTON
Bennett Engineering Associates, Inc.
P. O. Box 76
Mercer Island, WA 98040
Phone: (206) 232-3550

Custom Video Systems, Inc.
17521 15th Avenue N. E.
Seattle, WA 98155
Phone: (206) 365-5400

Northwest Electronics, Inc.
730 E. 1st Avenue
Spokane, WA 99220
Phone: (509) 535-7651

WISCONSIN
Video Images
12200 W. Adler Lane
Milwaukee, WI 53214
Phone: (414) 475-0111

SPECTRUM ANALYZERS & SWEPT FREQUENCY SYSTEMS

CONTENTS

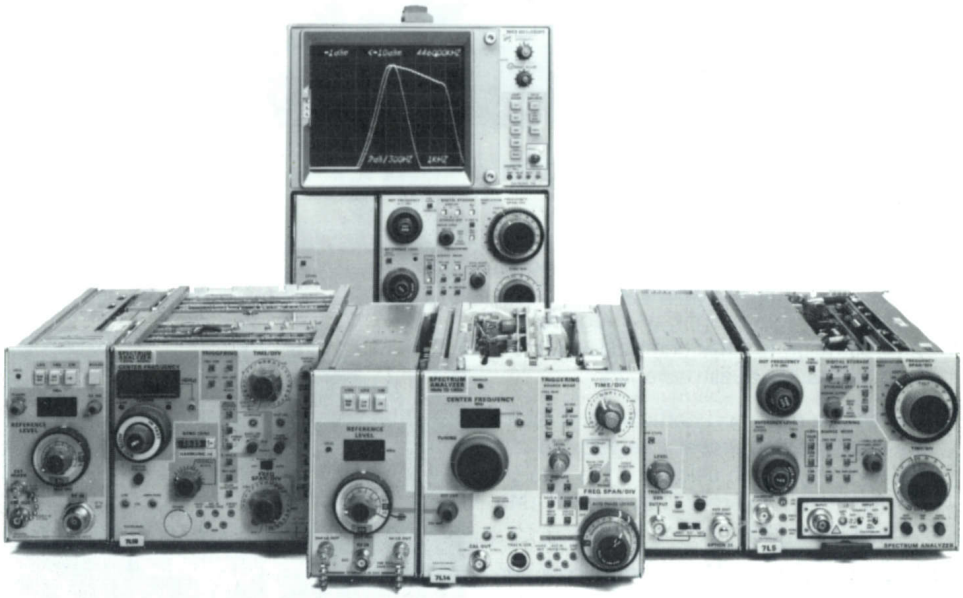
Portable Spectrum Analyzers
492/492P 50 kHz to 220 GHz 211
Waveguide Mixers 214
496/496P 1 kHz to 1800 MHz 215

Plug-in Spectrum Analyzers
7L18 1.5 GHz to 60 GHz 217
7L14 10 kHz to 1800 MHz 218
7L12 100 kHz to 1800 MHz 219
7L5 20 Hz to 5 MHz 221

Tracking Generators
TR 502/TR 503 100 kHz to 1800 MHz 223

1405 TV Sideband Adaptor 224

Accessories 225

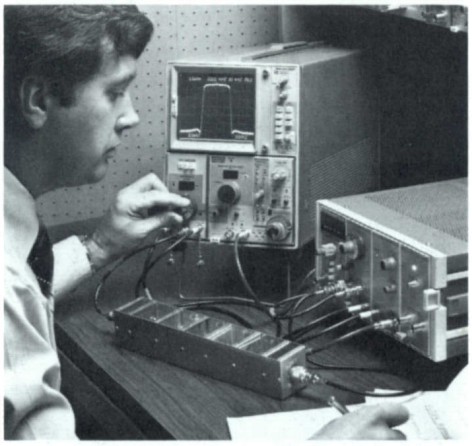


7000 Series Plug-in Versatility

No One Plug-in Spectrum Analyzer Meets Every Need. So There's a Choice of Four...to Best Meet Yours.
These easy-to-use plug-in models cover 20 Hz to 60 GHz, with individual ranges appropriate for applications from audio/ baseband to microwave measurement. A variety of features let you select the capability you need. They share the versatility that is basic to the Tektronix plug-in concept—there are over 30 other test and measurement plug-ins.

7000 Series Characteristics Make Spectrum Analysis Easier.
The 7L plug-in family displays CRT readout for referencing and easy documentation. And each analyzer is compatible with any Tektronix 7000 Series oscilloscope mainframe including the 7854 digitizing GPIB unit which offers programmable solutions to complex measurements.*[1]

[1] For detailed information on the comprehensive 7000 Series instruments, refer to pages 236 to 283.

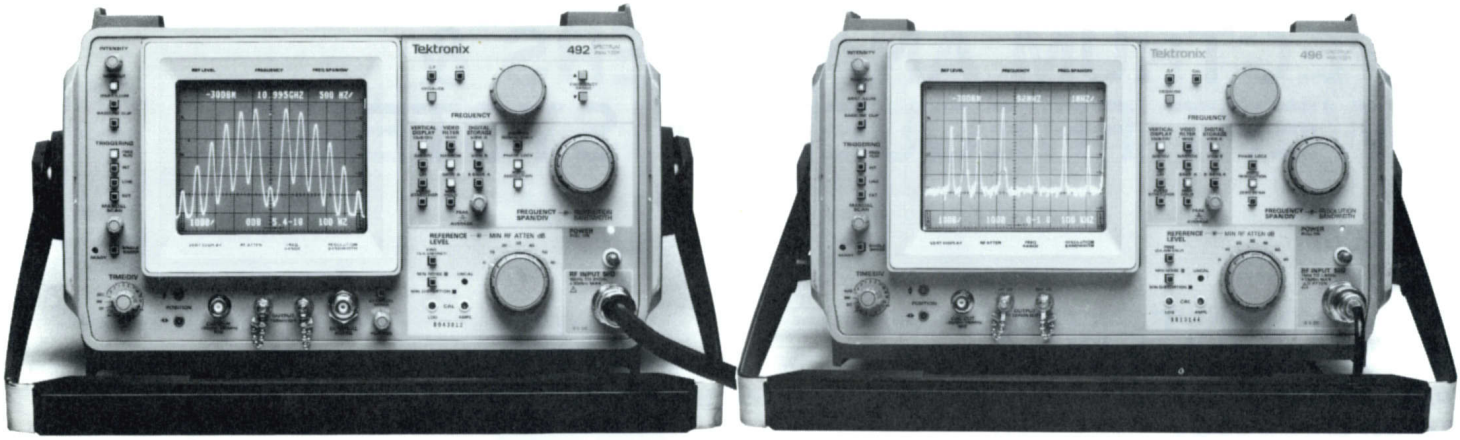


Three Models Provide Digital Storage.
For high performance with convenience, there's our digital storage family of plug-ins, the 7L5, 7L14, and 7L18. They cover 20 Hz to 60 GHz, with performance in the microwave frequencies that is comparable to what you expect in the baseband region.

Digital storage provides clean, flicker-free displays, plus valuable functions such as digital averaging and peak detection, waveform comparison and subtraction and a Max Hold function to measure long term amplitude and frequency changes.

Here's High Performance with Economy.
The VHF/UHF 7L12 plug-in brings you capabilities similar to the 7L14, but without digital storage and with minimum resolution of 300 Hz instead of 30 Hz.

Match Your Needs with Unmatched Value.
All these instruments point up both the immediate and long-term value of the Tektronix plug-in concept. If you already own a 7000 Series mainframe, you select only the analyzer plug-ins that cover your requirements, without paying for more capability than you need. And with all Tektronix spectrum analyzers, come a large choice of accessories, worldwide service and technical support.



Performance for the Lab that goes into the Field

The Tektronix 492 and 496 are two spectrum analyzers that go where you go. Their compact size, light weight, and rugged design combine to offer unmatched portability in laboratory quality analyzers.

Single-handle carry and portable form factor make them ready to travel. The 492 and 496 move as easily in the field as in the design lab or systems test area. They even fit under an airplane seat.

You can count on the same exceptional performance no matter where you're working. If its antenna test measurements, point-to-point transmission maintenance, or any number of critical field applications, the 492 and 496 work with you.

For on-site applications, reduced warmup time means reduced measurement time. Typical long-term frequency drift of 5 kHz/10 minutes after 30 minute warm up for the 492 and 492P; 2 kHz/10 minutes after 30 minute warm up for the 496 and 496P.

Here's Proof of Their Performance

The Tektronix 492 has the widest amplitude calibrated frequency range of any spectrum analyzer on the market: 50 kHz to 220 GHz —to 21 GHz in coax, from 18 GHz to 220 GHz using Tektronix external waveguide mixers. The VHF/UHF 496 covers from 1 kHz to 1.8 GHz.

They offer 80 dB dynamic range on-screen and excellent sensitivity, with an average noise level of −123 dBm at 100 Hz resolution bandwidth for the 492, −127 dBm at 30 Hz resolution bandwidth for the 496. Low phase noise −70 dBc at only 3 kHz offset —for accurate small-signal analysis. High stability for signal source spectral purity analysis, with residual FM of no more than 50 Hz peak-to-peak for the 492, 10 Hz peak-to-peak for the 496. For precise measurement of signal differences, there's amplitude comparison in super-fine 0.25 dB steps. And the 496 provides 1 kHz frequency resolution in ΔF mode. All this and more in one compact package that goes where you go.

Programmability/IEEE (GPIB) Compatibility

The GPIB interface enables full control of all measurement settings. Additional control of horizontal (span) and vertical display (1 dB to 15 dB/div) and smart functions (such as signal search) provide added measurement versatility. A desktop computer or computer controller (4052A or 4041) and a 492P or 496P Spectrum Analyzer provide repetitive measurements, data collection, and consistent, rapid results. Automated testing and monitoring may include data correction and analysis enabling complex measurements such as total harmonic distortion and power spectral density. The thermal printer of the 4041 or hard copiers for 4052A simplify documenting tests and spectral displays in hard copy form.

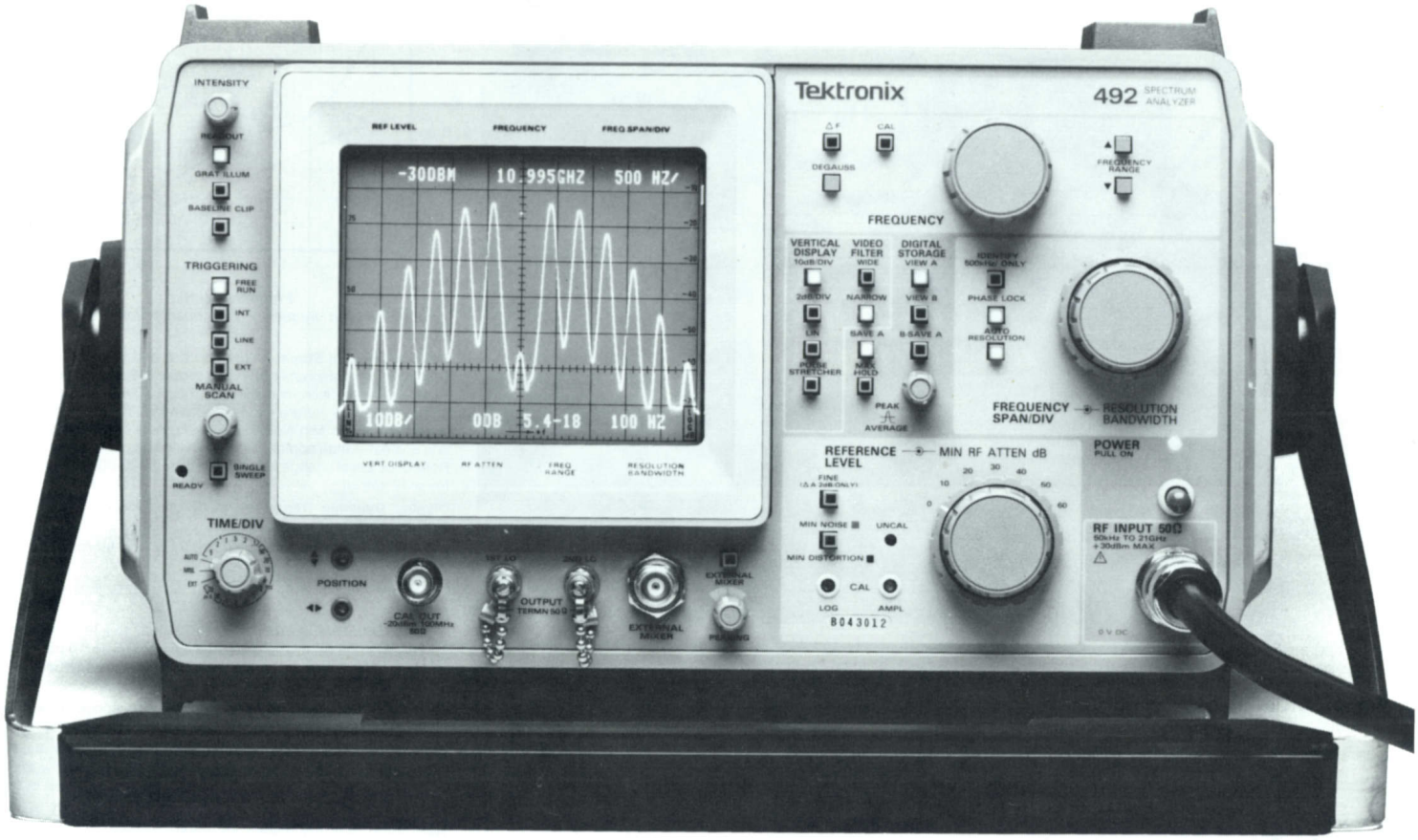
Programmability Now—or Later

Most manual 490 Series spectrum analyzers can be converted into fully programmable, GPIB compatible analyzers. Conversion may be performed via the Tektronix Service Center near you.

Easy to Use—Anywhere

Tektronix designed the 492 and 496 to handle your measurement task with microprocessor-aided ease. Setting frequency, span and reference level is a simple three-knob operation. Most-used functions are automatically controlled. Digital storage and signal processing eliminate time-consuming display adjustments. And constant tuning rate helps you position a signal quickly and accurately. All part of the convenience and capability the 492 and 496 deliver, on site or on the bench.

Tektronix offers service training classes on the 490 Portable Spectrum Analyzers. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.



GPIB IEEE-488 **492P** **492**

The 492P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

- **Microprocessor Aided Controls**
- **Automatic Modes**
- **Portable Form Factor (Compact Size/Lightweight)**
- **50 kHz to 220 GHz Frequency Range**
- **Amplitude Comparison in 0.25 dB Steps**
- **CRT Readout of All Important Parameters**
- **Fully Calibrated in Amplitude and Frequency**
- **80 dB Dynamic Range**
- **Wide Range of Options**
- **GPIB/Fully Programmable (492P)**
- **Three-Knob Operation**
- **Environmentalized per MIL-T-28800C**
- **Digital Storage and Signal Processing**
- **Freedom from Spurious Responses Through Preselection**

Lab Quality You Can Get a Handle On

The 492 is a high performance, rugged, state-of-the-art instrument of compact size, with microprocessor logic control. Full programmability via GPIB (IEEE Standard 488-1978) compatibility is available in the 492P version.

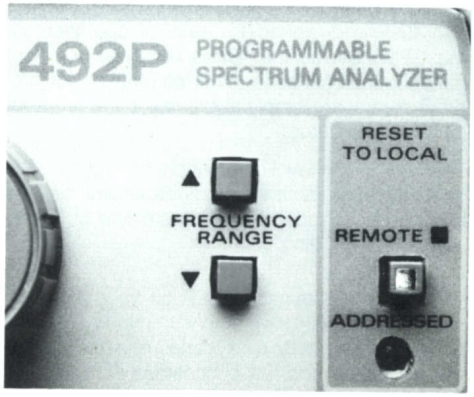
Three-knob operation provides use as simple as 1, 2, 3 through microprocessor coupled functions such as resolution bandwidth, video bandwidth, sweep time, frequency span, RF attenuation, and reference level. Measurement accuracy is enhanced through the use of Δ dB mode, which switches in 0.25 dB steps.

Digital storage and processing facilitate trace comparisons and add measurement capability through the Max Hold function for frequency drift and amplitude change measurements. Arithmetic operations can be performed between traces or between a trace and a reference. Digital noise averaging mode results in trace smoothing. With digital storage, the display is steady and without flicker, even at the lowest sweep speeds; plus trace values may be retained as long as power is on.

492P Makes Spectrum Analysis Automatic, and Easy.

Two instruments in one, the 492P is a fully programmable version of the 492 Spectrum Analyzer. It incorporates all of the 492's lab quality performance and ease of use features when used as a manual instrument. Push the "Reset to Local" button and the 492P becomes a 492—with operation from the front panel. But, most important, the 492P opens the way to automated spectrum analysis and documentation via its IEEE Standard-488 (GPIB) interface. This versatility makes the 492P useful in many applications in the lab, factory or field.

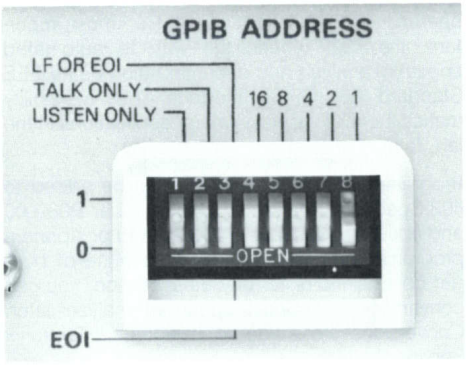
Programmability/GPIB features can be added to 492 Spectrum Analyzers, serial number B030000 and above. This means if you want to postpone a programmability/GPIB decision because of budget constraints, or for any other reason, you can convert your 490 Series spectrum analyzer later. Conversions are made at designated Tektronix Service Centers.



When used with the Tektronix 4052A Graphic Computing System Controller and 4631 Hard Copy Unit, or with the 4662 Digital Plotter, the 492P can provide test results in both graphic and numeric form for the evaluation of microwave signal sources.

Remotely Controllable via GPIB

Switches on the rear panel select the mode of operation as a GPIB instrument. In the normal Talker/Listener mode, the 492P listens to and executes commands from a GPIB controller. All important front panel settings can be operated remotely. Some functions are controlled with more detail through the GPIB than possible from the front panel.



Easy to Use

The 492P is designed for ease of operation via the GPIB, just as the 492 is designed for front panel operational ease. Most commands for program control are simply abbreviations of the front panel nomenclature.

The 492P's high level command language and the similarity of commands and responses simplify programming and make program listings easily readable for editing.

Put it to Work

With the programmable 492P on your measurement team, repetitive measurements can be done the same way every time. Your throughput will increase—and your confidence in results. And, the internal processing and high level programming language makes software development faster. You get high power results with easy programming. When you look at the total performance capability of the 492P, you'll recognize its value: ease of operation both as a programmable and manual instrument. Wide frequency range. The versatility to go where you go. Into the lab for automated testing; into the field for data collection.

The Tektronix 4932 GPIB Extender provides a cost-effective way to interconnect remotely located GPIB instruments, allowing communication at distances of up to 500 meters (1650 feet). See page 132 for additional information.

For more information on the application and benefits of the 490 Series Spectrum Analyzers under program control, ask for brochure 26W-5177.

CHARACTERISTICS

The following characteristics and features apply to the 492/492P Spectrum Analyzers after a 30 minute warmup period unless otherwise noted.

FREQUENCY RELATED

Center Frequency Range — 50 kHz to 21 GHz standard, amplitude specified coverage to 220 GHz with optional Tektronix waveguide mixers.

Frequency Accuracy — ±(5 MHz +20% of span/div) or ±(0.2% of the center frequency +20% of span/div) whichever is greater after 2 hour warmup.

Readout Resolution — Within 1 MHz.

Frequency Span/Div Range — 10 kHz to 500 MHz/Div in a 1-2-5 sequence in the 50 kHz to 21 GHz Center Frequency Range. Option 03 provides additional span ranges of 500 Hz, 1 kHz, 2 kHz, and 5 kHz/Div.

Span Accuracy — ±5% of span/div, measured over center 8 divisions.

Resolution Bandwidth (−6 dB Points) — 1 MHz to 1 kHz (100 Hz for Option 03) in decade steps, plus an Auto position. Resolution is within 20% of selected bandwidth.

Resolution Shape Factor (60/6 dB) — 7.5:1 or less.

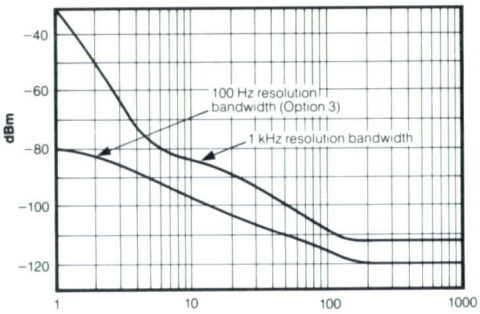
Residual FM — 1 kHz p-p for 2 ms time duration, improves to (50 Hz) for 20 ms with phaselock Option 03.

Long Term Drift (At Constant Temperature and Fixed Center Frequency) — 3 kHz/10 minutes after one hour warmup with Option 03 for fundamental mixing.

Noise Sidebands — At least −75 dBc at 30X Resolution offset from the center frequency (−70 dBc for 100 Hz resolution bandwidth Option 03).

AMPLITUDE RELATED

Reference Level Range — Full screen, top of graticule −123 dBm to +40 dBm (+40 dBm, includes maximum safe input of +30 dBm and 10 dB gain of IF gain reduction) for 10 dB/div and 2 dB/div log modes. 1 W maximum safe input in the linear mode.



Typical low end frequency performance for the 492 with Option 01.

Reference Level Steps — 10 dB, 1 dB, and 0.25 dB for relative level (Δ) measurements in Log mode. 1-2-5 sequence and 1 dB equivalent increments in Lin mode. The RF attenuator steps 10 dB for reference level changes above −30 dBm (−20 dBm when Min Noise is active) unless Min RF attenuation is greater than nomal. The IF gain increases 10 dB for each Reference Level change below −30 dBm (−20 dBm when Min Noise is active).

Display Dynamic Range — 80 dB at 10dB/Div, 16 dB at 2 dB/Div and 8 div in linear mode.

Reference Level Accuracy — Accuracy is a function of the characteristics listed below.

Calibrator — (Cal out) See output signal characteristics on next page.

Input Attenuator Accuracy — 0.3 dB/10 dB to a maximum of 0.7 dB over the 60 dB range, up to 4 GHz; 0.5 dB/10 dB to a maximum of 1.4 dB over the 60 dB range from 4 GHz to 21 GHz.

Frequency Response — See frequency response table on next page.

Display Amplitude Accuracy — ±1.0 dB/10 dB to a maximum cumulative error of ±2.0 dB over the 80 dB window and ±0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over the 16 dB window. Lin Mode is 5% of full scale.

Resolution Bandwidth Gain Variation — ±0.5 dB.

IF Gain Variation — ±0.2 dB/dB to a maximum of ±2 dB over the 90 dB range.

SPURIOUS RESPONSES

Residual (No Input Signal Referenced to Mixer Input) — −100 dBm or less.

Harmonic Distortion (cw Signal, Min Distortion Mode) — At least −60 dBc for full screen signal in the Min Distortion mode to 21 GHz. At least −100 dBc for preselected Option 01. 1.7 to 21 GHz.

Third-Order Intermodulation Distortion (Min Distortion Mode) — At least 70 dB down from two full screen signals within any frequency span. At least 100 dB down for two signals spaced more than 100 MHz apart from 1.7 to 21 GHz for preselected Option 01.

LO Emissions (Referenced to Input Mixer) — −10 dBm maximum; −70 dBm maximum to 21 GHz for Option 01.

INPUT SIGNAL CHARACTERISTICS

RF Input — Type N female connector.

Input Impedance — 50 Ω.

Maximum VSWR*[1] with ≥10 dB Attenuation

Frequency Range	Typical	Specified Maximum
Dc to 2.5 GHz	1.2:1	1.3:1
2.5 GHz to 6.0 GHz	1.5:1	1.7:1
6.0 GHz to 18 GHz	1.9:1	2.3:1
18 GHz to 21 GHz	2.7:1	3.5:1

*[1] *At Type N female connector to internal mixer, with 10 dB attenuation*

Input Level (Optimum Level for Linear Operation) — −30 dBm referenced to input mixer. Full screen not exceeded and Min Distortion control settings.

1 dB Compression Point — −18 dBm except −28 dBm at 1.7 GHz to 2 GHz for Option 01 only.

Maximum Safe Input Level (RF Attenuation at Zero dB) — +13 dBm without Option 01. +30 dBm (1 W) with Option 01.

Maximum Input Level (with 20 dB or more RF Attenuation) — +30 dBm (1 W) continuous, 75 W peak for 1 μs or less pulse width and 0.001 maximum duty factor (attenuation limit). Dc must never be applied to RF input.

SENSITIVITY AND FREQUENCY RESPONSE

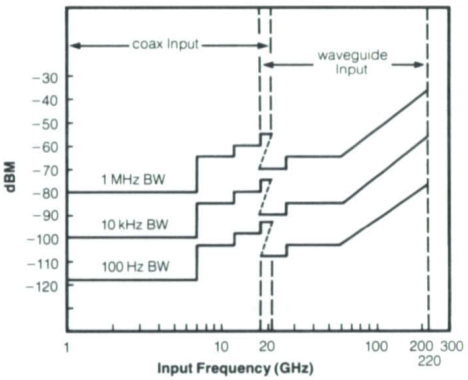
Frequency Range	Mixing Number (n)	Average Noise Level for 1 kHz Resolution		Frequency Response With 10 dB Attenuation	
		No Preselection	Preselected Option 01	No Preselection	Preselected Option 01
50 kHz to 1.8 GHz*	1	−115 dBm	−110 dBm		±1.5 dB
50 kHz to 4.2 GHz*	1	−115 dBm	−110 dBm	±1.5 dB	
1.7 GHz to 5.5 GHz	1	−115 dBm	−110 dBm	±1.5 dB	±2.5 dB
3.0 GHz to 7.1 GHz	1	−115 dBm	−110 dBm	±1.5 dB	±2.5 dB
5.4 GHz to 18 GHz	3	−100 dBm	−95 dBm (12 GHz) −90 dBm (18 GHz)	±2.5 dB	±3.5 dB
15 GHz to 21 GHz	3	−95 dBm	−85 dBm	±3.5 dB	±5.0 dB
100 MHz to 18 GHz***				±3.5 dB	±4.5 dB
WITH TEKTRONIX OPTIONAL HIGH PERFORMANCE WAVEGUIDE MIXERS					
18 GHz to 26 GHz	6	−100 dBm		±3.0 dB	
26 GHz to 40 GHz	10	−95 dBm		±3.0 dB	
40 GHz to 60 GHz	10	−95 dBm		±3.0 dB	
60 GHz to 90 GHz	15	−95 dBm @ 60 GHz†		±3.0 dB**†	
		−85 dBm @ 90 GHz†		±3.0 dB**†	
90 GHz to 140 GHz	23	−85 dBm @ 90 GHz†		±3.0 dB**†	
		−75 dBm @ 140 GHz†		±3.0 dB**†	
140 GHz to 220 GHz	37	−65 dBm @ 220 GHz†		±3.0 dB**†	

** Low frequency end performance does not include effects due to 0 Hz feedthrough.*

*** Over any 5 GHz bandwidth.*

**** Includes frequency band switching error of 1 dB maximum.*

† Typical



OUTPUT SIGNAL CHARACTERISTICS

Calibrator (Cal Out) — −20 dBm ±0.3 dB, 100 MHz ±1.7 kHz.

1st and 2nd LO — Provides access to the output of the respective local oscillators (1st LO +7.5 dBm min to a max of +15 dBm; 2nd LO −22 dBm min to a max of +15 dBm). These ports must be terminated in 50 Ω at all times.

Vertical Out — Provides 0.5 V ±5% of signal/div of video above and below the center line.

Horizontal Out — Provides 0.5 V either side of center. Full range −2.5 V to +2.5 V ±10%.

Pen Lift — TTL, +5 V nominal to lift pen.

IF Out — Output of the 10 MHz IF. Level is approximately −16 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 Ω.

492P Only: IEEE Standard 488-1978 Port (GPIB) — In accordance with IEEE Standard 488.

GENERAL CHARACTERISTICS

Sweep Time — 20 μs to 5 s/div (10 s/div in auto) in 1-2-5 sequence.

CRT Readout — Displays reference level, center frequency, frequency range, vertical display mode, frequency span/div resolution bandwidth and RF attenuation.

CRT — 8 x 10 cm, GH (P31) Phosphor.

Input Voltage — 90 V ac to 132 V ac or 180 V ac to 250 V ac, 48 Hz to 440 Hz.

Power — 210 W max with all options, at 115 V and 60 Hz.

ENVIRONMENTAL CHARACTERISTICS

Per MIL-T-28800C Type III, Class 3, Style C.

Temperature — Operating: −15°C to +55°C. Nonoperating: −62°C to +75°C.

Humidity — Operating: 95%. Nonoperating: 120 hours per MIL-STD 810.

Rain Resistance — Drip proof at 16 liters/hour/square foot.

Altitude — Operating: 4500 m (15,000 ft). Nonoperating: 12 000 m (40,000 ft).

Vibration — 15 Hz to 55 Hz at 0.025 inch excursion.

Shock — 30 g of half sine 11 ms duration.

Drop — 12 inches.

Electromagnetic Compatibility — 490 Series spectrum analyzers meet the requirements of MIL-STD-461B, operating from 48 Hz to 440 Hz power sources, with the exceptions shown below.

Conducted Emissions — CE01: 15 dB relaxation for first 10 harmonics of power line frequency. CE03 (Narrowband): Full limits. CE03 (Broadband): 15 dB relaxation from 15 kHz to 50 kHz.

Conducted Susceptibility — CS01: Full limits. CS02: Full limits. CS06: Full limits.

Radiated Emissions — RE01: 10 dB relaxation for first 10 harmonics of power line frequency, and exceptioned from 30 kHz to 36 kHz. RE02: Full limits.

Radiated Susceptibility — RS01: Full limits. RS02-1: Full limits. RS02-2: To 5 A only. RS03: Up to 1 GHz only.

Configuration — Portable. 492/492P Option 1,2,3 total weight including front cover and standard accessories. 20 kg (49 lb), 17.5 x 32.7 x 49.9 cm (6.9 x 12.9 x 19.7 in) without handle or cover.

INCLUDED ACCESSORIES

6 ft N to N connector 50 Ω coaxial cable, (012-0114-00); 18 in BNC to BNC connector 50 Ω coaxial cable (012-0076-00); N male to BNC female adaptor (103-0045-00); CRT mesh filter (378-0726-01); 2 A fast blow fuse (159-0021-00); two 4 A fast blow fuse (159-0017-00); 115 V power cord (161-0118-00); cord clamp (343-0170-00); CRT visor (016-0653-00); diplexer assembly (015-0385-00); amber CRT light filter (378-0115-01); blue CRT light filter (378-0115-00); gray CRT light filter (378-0115-02); 492P also includes 2 m, double shielded GPIB cable (012-0630-03); operators manual; operators handbook; service manual.

490 Series Spectrum Analyzers Rackmount/Benchmount Options

The following options denote mechanical configurations of the 492/492P/496/496P. Option 30 is a rackmount configuration for the 490 Series with standard front panel input/outputs. Option 31 is a rackmount configuration with rear panel input/output capability. Option 32 adds side covers and trim to an Option 31 making it into a stackable bench top configuration.

The Option 30 and 31 Rackmount is a standard 19 inch rack width and comes with standard rackmount fittings. A spectrum analyzer accessories storage drawer is also included. Dimensions are 22.23 x 42.9 x 63.5 cm (8.75 x 16.89 x 25.0 in). Weight is 24.5 kg (59 lb); including the spectrum analyzer.

The Option 32 Benchmount is approximately the same size as the Rackmount but is dressed with side and top panels and carrying handles and feet. The Benchmount provides a convenient surface for stacking other instruments. Dimensions are 23.5 x 45.7 x 63.5 cm (9.25 x 17.9 x 25.0 in). Weight is 28.1 kg (62 lb); including the spectrum analyzer.

ORDERING INFORMATION

492 Spectrum Analyzer **$21,500**

492P Fully Programmable/GPIB Spectrum Analyzer **$28,600**

492 to 492P Conversion — Conversion made by your Tektronix Service Center. For 492's with Options 01, 02, 03, 08. Order 040-1038-02 ..... **$6,800**
For 492's with Options 01, 02, 03. Order 040-1037-02 .. **$6,800**

Option 01 — Internal Preselection ..... **+$3,900**
Provides calibrated preselected filtering of input to first mixer for each frequency band.

Option 02 — Digital Storage ..... **+$1,900**
Provides multiple memory display storage with Save A, Maximum Hold, B Minus Save A, display averaging, and storage bypass.

Option 03 — Frequency Stabilization/100 Hz Resolution ..... **+$3,500**
Provides first local oscillator stabilization by phase locking the oscillator to an internal reference.

Option 08 — Delete External Mixer Capability ..... **−$1,750**
Deletes internal switching front panel connector and external diplexer to connect and use external waveguide mixers.

Option 20 — General Purpose 12.4 GHz to 40 GHz Waveguide Mixer Set ..... **+$865**
Includes three mixers (12.4 GHz to 18 GHz, 18 GHz to 26.5 GHz, and 26.5 GHz to 40 GHz) and attaching hardware to extend the upper frequency.

Option 21 — High Performance 18 GHz to 40 GHz Waveguide Mixer Set ..... **+$2,475**
Includes two mixers (18 GHz to 26.5 GHz and 26.5 GHz to 40 GHz) and attaching hardware to extend the upper frequency.

Option 22 — High Performance 18 GHz to 60 GHz Waveguide Mixer Set ..... **+$4,155**
Includes three mixers (18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, and 40 GHz to 60 GHz) and attaching hardware to extend the upper frequency.

Option 30 — Rackmount. 19 inch rack width with front panel input/outputs ..... **+$790**

Option 31 — Rackmount. 19 inch rack width with rear panel input/output capability ..... **+$840**

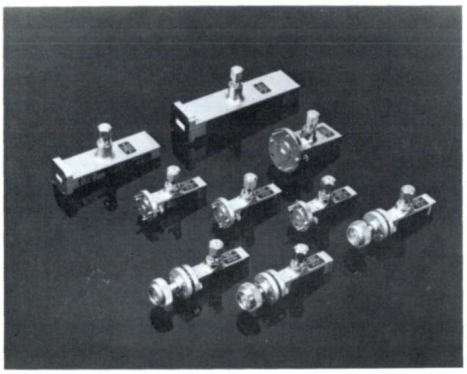
Option 32 — Benchmount. Adds side and top panels, carrying handles and feet for a stackable bench top configuration ..... **+$940**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

PERIPHERAL PRODUCTS FOR 492P SPECTRUM ANALYZER

4041 System Controller **$4,995**
4052A Graphic Computing System Controller **$9,900**
4611 Hard Copy Unit **$4,550**
4631 Hard Copy Unit **$5,950**
4662 Interactive Digital Plotter **$2,995**
4924 Digital Cartridge Tape Drive **$2,990**
4932 GPIB Extender **$1,195**



490 Series Waveguide Mixers

The 490 Series Tektronix Waveguide Mixers cover from 18 GHz to 220 GHz with optimum sensitivity. They are designed specifically for use with the Tektronix 492/492P and 7L18 Spectrum Analyzers.

The two microwave mixers cover ranges 18 GHz to 26.5 GHz and 26.5 GHz to 40 GHz. They have field replaceable diodes and frequency response of ±3 dB when used with the spectrum analyzers indicated above.

Seven millimeter wave mixers cover the 40 GHz to 220 GHz range in the standard Mil-spec band ranges. A mixer designed specifically for the 140 GHz to 220 GHz band is available, or a flange transition (119-1729-00) can be used to allow the 90 GHz to 140 GHz mixer to cover this range.

The mixers are all gold plated brass, conforming to MIL-G-45204 Class I, Type 1 specifications and will withstand harsh environments. Each set comes complete with a container for spare diodes, a 28-inch cable, an instruction manual and a wood storage box with foam cutout storage locations for five mixers.

CHARACTERISTICS

For All Waveguide Mixers — Maximum cw RF input level: +10 dBm (10 mW).

Maximum PULSED RF Input Level — 1 W peak with 0.001 maximum duty factor and 1 μs maximum pulse width.

L.O. Requirement — +7 dBm minimum, +15 dBm maximum, +10 dBm typical.

Bias Requirement — −2.0 V to +0.5 V with respect to the mixer body through a current limiting resistor, to provide 0 mV to 20 mA of bias current.

For the 18 GHz to 60 GHz Waveguide Mixers — 3 dB compression point (saturation): −10 dBm (typical).

Conversion Loss — 30 dB typical (when used in the proper spectrum analyzer frequency band).

ORDERING INFORMATION

Performance Specified Mixers and Sets:

18 GHz to 26.5 GHz Frequency Range —
Order WM 490K **$1,225**

26.5 GHz to 40 GHz Frequency Range —
Order WM 490A **$1,225**

40 GHz to 60 GHz Frequency Range —
Order WM 490U **$1,680**

50 GHZ to 75 GHz Frequency Range —
Order WM 490V **$1,950**

60 GHz to 90 GHz Frequency Range —
Order WM 490E **$2,075**

75 GHz to 110 GHz Frequency Range —
Order WM 490W **$2,075**

90 GHZ to 140 GHz Frequency Range —
Order WM 490F **$2,275**

110 GHz to 170 GHz Frequency Range —
Order WM 490D **$3,175**

140 GHz to 220 GHz Frequency Range —
Order WM 490G **$3,325**

18 GHz to 40 GHz Set Contains WM 490K, WM 490A —
Order WM 4902 ..... **$2,520**

18 GHz to 60 GHz Set Contains WM 490K, WM 490A and WM 490U — Order WM 4903 ..... **$4,200**

18 GHz to 90 GHz Set Contains WM 490K, WM 490A, WM 490U and WM 490E — Order WM 4904 ..... **$6,275**

18 GHz to 140 GHz Set Contains WM 490K, WM 490A, WM 490U, WM 490E, and WM 490F —
Order WM 4905 ..... **$8,550**

Cable — Order 012-0649-00 ..... **$50**

Case — Order 016-0465-01 ..... **$50**

140 GHz to 220 GHz tapered transition 119-1729-00 used with WM 490F waveguide mixer **$650**

General Purpose Waveguide Mixer and Set:

12.5 GHz to 18 GHz Frequency Range —
Order 119-0097-01 ..... **$190**

18 GHz to 26.5 GHz Frequency Range —
Order 119-0098-01 ..... **$290**

26.5 GHz to 40 GHz Frequency Range —
Order 119-0099-01 ..... **$360**

Cable — Order 012-0748-00 ..... **$60**

Case — Order 016-0465-01 ..... **$50**

12.5 GHz to 40 GHz Set Contains 119-0097-01, 119-0098-01, 119-0099-01 — Order 016-0640-00 ..... **$740**

OPTIONAL ACCESSORIES

Microwave Comb Generator TM 500 Series Compatible —
Order 067-0885-00 ..... **$1,800**

75 Ω to 50 Ω Minimum Loss Pad —
Order 011-0112-00 ..... **$60**

Dc Block BNC to BNC — Order 015-0221-00 ..... **$85**

FET Probe P6201 to 900 MHz — Order 010-6201-01 **$1,145**

1405 TV Sideband Adaptor (525/60 Markers) **$5,670**

C-5C Camera **$530**

TV Trigger Synchronizer — Order 015-0261-01 ..... **$395**

Hard Case (Transit) — Order 016-0658-00 ..... **$625**

Soft Case — Order 016-0659-00 ..... **$125**

Lab Cart Model 3 ..... **$560**

Note: 490 Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras. Battery Pack 016-0270-02 is required for C-50, C-51, C-52 and C-53 Cameras.

ELECTRICAL CHARACTERISTICS

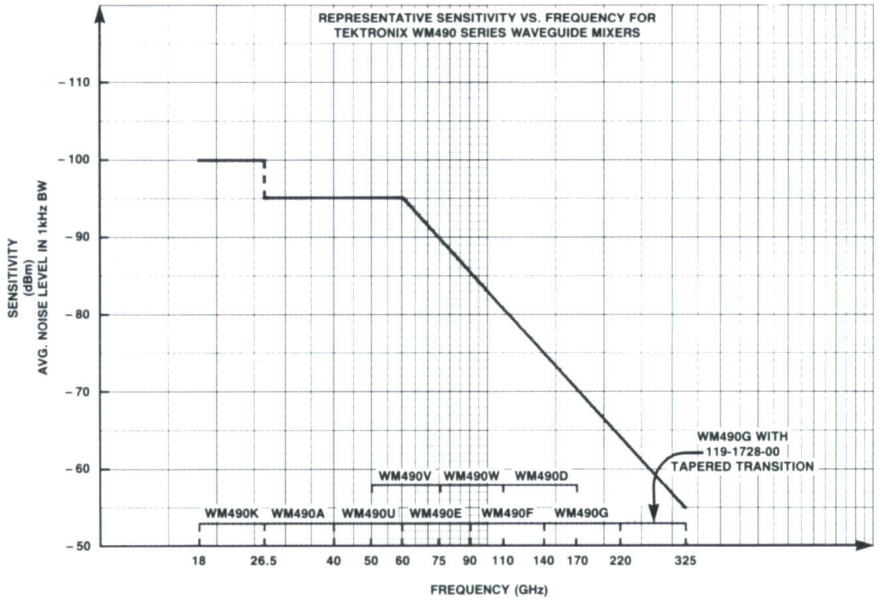
Frequency Range (GHz)	Tektronix Model No	Band Designation	Sensitivity (dBm)*1	Frequency Response*2	Amplitude Accuracy*3	3 dB Compression Point (Saturation)
18 to 26.5	WM 490K	K	−100	±3 dB	±6 dB	−10 dBm typical
26.5 to 40	WM 490A	A	−95	±3 dB	±6 dB	−10 dBm typical
40 to 60	WM 490U	U	−95	±3 dB	±6 dB	−10 dBm typical
50 to 75	WM 490V	V	−95 at 50 GHz	±3 dB		−10 dBm at 50 GHz
			−90 at 75 GHz	typical*4		−10 dBm at 75 GHz
			typical			typical
60 to 90	WM 490E	E	−95 at 60 GHz	±3 dB		−10 dBm at 60 GHz
			−85 at 90 GHz	typical*4		−5 dBm at 90 GHz
			typical			typical
75 to 110	WM 490W	W	−90 at 75 GHz	±3 dB		−10 dBm at 75 GHz
			−80 at 110 GHz	typical*4		0 dBm at 110 GHz
			typical			typical
90 to 140	WM 490F	F	−85 at 90 GHz	±3 dB		−5 dBm at 90 GHz
			−75 at 140 GHz	typical*4		0 dBm at 140 GHz
			typical			typical
110 to 170	WM 490D	D	−80 at 110 GHz	±3 dB		0 dBm at 110 GHz
			−70 at 170 GHz	typical*4		+5 dBm at 170 GHz
			typical			typical
140 to 220	WM 490G	G	−75 at 140 GHz	±3 dB		0 dBm at 140 GHz
			−65 at 220 GHz	typical*4		+10 dBm at 220 GHz
			typical			typical

*1 *Equivalent average noise level at 1 kHz bandwidth.*

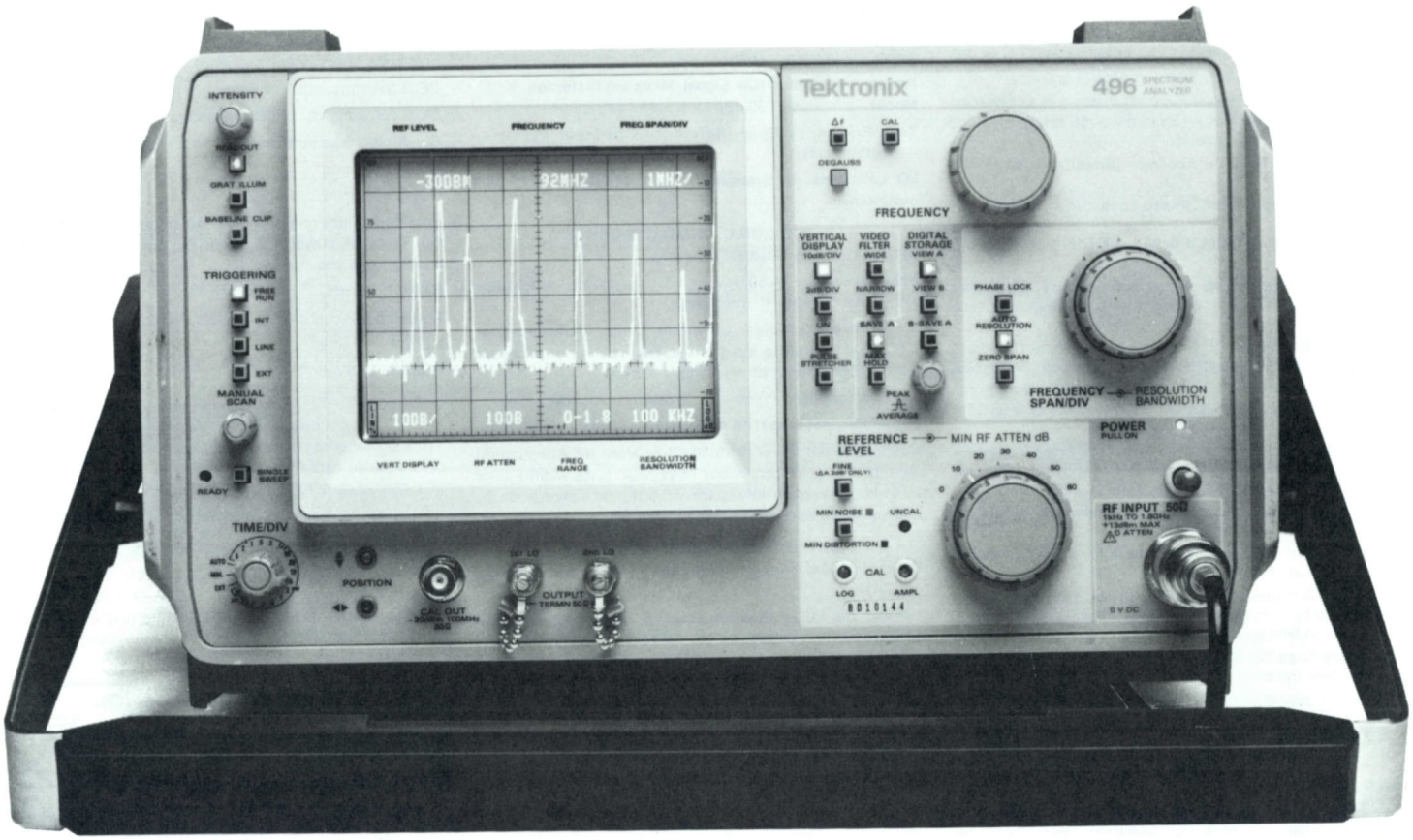
*2 *Maximum amplitude variation across each waveguide mixer band (with peaking control optimized at each frequency in response to a −30 dBm CW input signal to the mixer).*

*3 *Maximum reference level error with respect to the internal calibrator. Amplitude accuracy can be improved 3 dB by measuring amplitude with respect to a known external (waveguide) reference signal.*

*4 *Over any 5 GHz bandwidth for millimeter wave mixers above 60 GHz.*



SPECTRUM ANALYZERS



GPIB IEEE-488 **496P** **496**

The 492P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Microprocessor Aided Controls

Automatic Modes

Portable Form Factor (Compact Size/Light Weight)

1 kHz to 1800 MHz Coverage

Amplitude Comparison in 0.25 dB Steps

1 kHz Frequency Resolution in ΔF Mode

CRT Readout of all Important Parameters

Fully Calibrated in Amplitude and Frequency

80 dB Dynamic Range

GPIB/Fully Programmable (496P)

Three-knob Operation

Environmentalized per MIL-T 28800C

Digital Storage and Signal Processing

The 496 provides high performance spectrum analysis and measurements in the 1 kHz to 1.8 GHz range. Its high stability and 80 dB dynamic range meet your demands for proof-of-performance measurements, on site or on the bench.

The 496 offers state-of-the-art performance and rugged portability. Resolution bandwidth can be varied from 1 MHz to 30 Hz over the entire frequency range. Automatic phase lock stabilization reduces incidental FM to 10 Hz p-p; phase noise sidebands are at least −75 dBc at 30 times the resolution offset. Frequency drift with phase lock is typically 1 kHz in 10 minutes after 30 minute warmup. And the 496 provides 1 kHz frequency resolution in ΔF mode.

Easy to use—Anywhere

Simple 1,2,3 knob adjustment sets center frequency, frequency span and reference level. Power on sequence automatically normalizes operational settings and provides maximum input protection.

Digital storage eliminates time-consuming display adjustments. Save A, B Minus Save A, Max Hold and Average modes let you compare, subtract, save maximum values or noise average (smooth) your spectral displays. Constant tuning rate lets you position the signal quickly and accurately at any frequency span.

Microprocessor-aided controls take care of the rest. Most-used functions are automatically controlled.

The 496 Goes Where You Go

Lightweight and compact size combine to provide unmatched portability in a laboratory quality spectrum analyzer. With its single-handle carry, the 496 is easily moved around the design lab or systems test area, to the field, or wherever it may be needed. It even fits under an airplane seat.

Automate your Spectrum Analysis with the 496P

The 496P is the fully programmable/GPIB compatible version of the 496 Spectrum Analyzer. Operation, features and benefits of the 496P are essentially the same as the 492P. See discussion on pages 211 thru 213. 496 Spectrum Analyzer specifications also apply to the 496P.

The Tektronix 4932 GPIB Extender provides a cost-effective way to interconnect remotely located GPIB instruments, allowing communication at distances of up to 500 meters (1650 feet). See page 132 for additional information.

Manual instruments can be converted to programmable instruments at a later time. Contact your Tektronix Sales Engineer for details.

CHARACTERISTICS

The following characteristics and features apply to the 496/496P Spectrum Analyzers after a 30 minute warmup period unless otherwise noted.

FREQUENCY RELATED

Center Frequency Range — 1 kHz to 1800 MHz.

Frequency Accuracy — ±5 MHz +20% of span/div.

Frequency Readout Resolution*1 — Within 1 MHz. 496P Tune Command Accuracy (Span/div ≤50 kHz): ±7% or ±100 Hz, whichever is greater.

Delta Frequency Readout Accuracy (Span/Div ≤50 kHz)*1 — ±5%.

Residual FM (Short Term), Phase Lock On — ≤10 Hz p-p over 20 ms.

Residual FM (Short Term), Phase Lock Off — ≤1 kHz p-p over 20 ms.

Long Term Drift (at Constant Temperature and Fixed Center Frequency) — 330 Hz/10 minutes after 1 hour warmup phase locked.

Resolution Bandwidth (−6 dB) — 30 Hz, then 100 Hz to 1 MHz in decade steps, plus an Auto position. Resolution bandwidth is within 20% of selected bandwidth.

Resolution Shape Factor (60 dB/6 dB) — 7.5:1 or less. 15:1 or less for 30 Hz resolution bandwidth.

Noise Sidebands — At least −75 dBc at 30 times the resolution bandwidth offset from the center frequency (−70 dBc for 100 Hz resolution bandwidth or less).

Frequency Span/Div Range — From 50 Hz/div to 100 MHz/div in a 1-2-5 sequence.

Maximum Span — When selected, the entire effective frequency range is scanned and displayed.

Zero Span — When selected, the horizontal axis of the CRT is calibrated in time (instead of frequency). The span/div readout is changed to time/div.

Frequency Span/Div Accuracy — Within 5% of the selected span/div over the center 8 div of the 10 div CRT display.

**1 ΔF mode provides measurements to the nearest kHz plus direct center frequency readout to the nearest kHz between 1 kHz and 500 kHz.*

AMPLITUDE RELATED

Reference Level Range (Full Screen, Top of Graticule) — −123 dBm to +40 dBm (+40 dBm includes maximum safe input of +30 dBm and 10 dB of IF gain reduction) for 10 dB/div and 2 dB/div Log modes. 20 nV/div to 2 V/div (1 W maximum safe input) in Lin mode.

Reference Level Steps — 10 dB, 1 dB, and 0.25 dB for relative level (Δ) measurements in Log mode. 1-2-5 sequence and 1 dB equivalent increments in Lin mode. The RF attenuator steps 10 dB for reference level changes above −30 dBm (−20 dBm when Min Noise is active) unless Min RF attenuation is greater than normal. The IF gain increases 10 dB for each Reference Level change below −30 dBm (−20 dBm when Min Noise is active).

Display Dynamic Range — 80 dB at 10 dB/div, 16 dB at 2 dB/div, and 8 div in Linear mode.

Reference Level Accuracy — Accuracy is a function of the following characteristics.

Calibrator: (Cal out). See output signal characteristics.

Input Attenuator Accuracy: 0.3 dB/10 dB to a maximum of 0.7 dB over the 60 dB range, 1 kHz to 1.8 GHz.

Display Amplitude Accuracy: ±1.0 dB/10 dB to a maximum cumulative error of ±2.0 dB over the 80 dB window and ±0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over the 16 dB window. Lin mode is 5% of full scale.

Resolution Bandwidth Gain Variation: ±0.5 dB.

IF Gain Variation: ±0.2 dB/dB to a maximum of ±2 dB over the 90 dB range.

Display Flatness — ±1.5 dB, 1 kHz to 1800 MHz measured with ≥10 dB RF attenuation.

Sensitivity

Resolution Bandwidth	Average Noise Level
30 Hz	−127dBm
100 Hz	−123 dBm
1 kHz	−115 dBm
10 kHz	−105 dBm
100 kHz	−95 dBm
1 MHz	−85 dBm

SPURIOUS RESPONSE

Residual (No Input Signal) — −100 dBm or less referenced to mixer input.

Third-Order Intermodulation Distortion (Minimum Distortion Mode) — At least −70 dBc below any two on-screen signals within any frequency span.

Harmonic Distortion (Cw Signal, Minimum Distortion Mode) — At least −60 dBc for a full-screen signal.

Zero Frequency Spur (Referenced to Input Mixer) — −20 dBm or less.

LO Emissions (Referenced to Input Mixer) — −70 dBm maximum.

INPUT SIGNAL CHARACTERISTICS

RF Input — Type N female connector.

Input Impedance — 50 Ω; vswr 1.3:1 maximum (1.2:1 typical) with 10 dB or more RF attenuation.

Input Level (Optimum Level for Linear Operation) — −30 dBm referred to input mixer. Full screen not exceeded and Min Distortion control setting.

1 dB Compression Point — −18 dBm, no RF attenuation.

Maximum Input Level (RF Attenuation at 0 dB) — +30 dBm.

Maximum Input Level (with 20 dB or More RF Attenuation) — +30 dBm (1 W) continuous 75 W peak, pulse width 1 μs or less with a maximum duty factor of 0.001 (attenuation limit). Dc must never be applied to RF input.

OUTPUT SIGNAL CHARACTERISTICS

Calibrator (Cal Out) — −20 dBm ±0.3 dB at 100 MHz ±1.7 kHz.

1st and 2nd LO — Provides access to the output of the respective local oscillators (1st LO +6 dBm minimum to a maximum of +15 dBm, 2nd LO −16 dBm minimum to a maximum of +15 dBm). These ports must be terminated in 50 Ω at all times.

Vertical Out — Provides 0.5 V ±5% of signal/div of video above and below the centerline.

Horizontal Out — Provides 0.5 V either side of center. Full range −2.5 V to +2.5 V ±10%.

Pen Lift — TTL compatible, nominal +5 V to lift pen.

IF Out — Output of the 10 MHz IF. Level is ≈−16 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 Ω.

496P Only IEEE Standard 488-1978 Port (GPIB) — In accordance with IEEE Standard 488.

Probe Power — Provides operating voltages (+5 V, +15 V, −15 V, and ground) for active probes.

GENERAL CHARACTERISTICS

Sweep Time — 20 μs/div to 5 s/div in 1-2-5 sequence (10 s/div in Auto).

CRT Readout — Displays: Reference Level, Frequency, Frequency Span/Div, Vertical Display, RF attenuation, and Resolution Bandwidth.

CRT — 8 x 10 cm. GH (P31) Phosphor is standard.

Configuration — (Portable) 496/496P total weight including front cover and standard accessories 20 kg (44 lb), 17.5 x 32.7 x 49.9 cm (6.9 x 12.9 x 19.7 in) without handle or cover.

Input Voltage — 90 V ac to 132 V ac or 180 V ac to 250 V ac, 48 Hz to 440 Hz.

Power — 210 W maximum, 3.2 A, at 115 V and 60 Hz.

ENVIRONMENTAL CHARACTERISTICS

Per MIL-T-28800C, Type III, Class 3, Style C.

Temperature — Operating: −15°C to +55°C. Nonoperating: −62°C to +75°C.

Humidity — Operating: 95%. Nonoperating: 120 hours per MIL-STD 810.

Rain Resistance — Drip proof at 16 liters/hour/square foot.

Altitude — Operating: 4500 m (15,000 ft). Nonoperating: 12 000 m (40,000 ft).

Vibration — 15 Hz to 55 Hz at 0.025 inch excursion.

Shock — 30 g of half sine 11 ms duration.

Drop — 12 inches.

Electromagnetic Compatibility — 490 Series spectrum analyzers meet the requirements of MIL-STD-461B, operating from 48 Hz to 440 Hz power sources, with the exceptions shown below.

Conducted Emissions — CE01: 15 dB relaxation for first 10 harmonics of power line frequency.

CE03 (Narrowband): Full limits.

CE03 (Broadband): 15 dB relaxation from 15 kHz to 50 kHz.

Conducted Susceptibility — CS01: Full limits.

CS02: Full limits.

CS06: Full limits.

Radiated Emissions — RE01: 10 dB relaxation for first 10 harmonics of power line frequency, and exceptioned from 30 kHz to 36 kHz.

RE02: Full limits.

Radiated Susceptibility — RS01: Full limits.

RS02-1: Full limits.

RS02-2: To 5 A only.

RS03: Up to 1 GHz only.

INCLUDED ACCESSORIES

115 V power cord (161-0118-00); 6 ft N to N connectors 50 Ω coaxial cable (012-0114-00); 18 in BNC to BNC connectors 50 Ω coaxial cable (012-0076-00); N male to BNC female adaptor (103-0045-00); cord clamp (343-0170-00); two 4 A fast blow fuse (159-0017-00); 2 A fast blow fuse (159-0021-00); CRT visor (016-0653-00); CRT mesh filter (378-0726-01); blue CRT light filter (378-0115-00); amber CRT light filter (378-0115-01); gray CRT light filter (378-0115-02); 496P also includes 2 meter double shield GPIB cable (012-0630-03); operators manual; service manual; operators handbook; programmers manual.

ORDERING INFORMATION

496 Spectrum Analyzer **$23,050**

496P Fully Programmable/GPIB Spectrum Analyzer **$27,950**

496 to 496P Conversion (040-1046-02) — Conversions made by your Tektronix Service Center. Contact your Spectrum Analyzer Sales Engineer or Service Center for details **$4,800**

Option 30 — Rackmount 19 inch rack width with front panel input/outputs ..... **+$790**

Option 31 — Rackmount 19 inch rack width with rear panel input/output capability ..... **+$840**

Option 32 — Benchmount adds side and top panels, carrying handles and feet for a stackable benchtop configuration ..... **+$940**

INTERNATIONAL POWER CORDS & PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 , 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 250 V/10 A, 50 Hz

PERIPHERAL PRODUCTS FOR 496P SPECTRUM ANALYZER

4041 System Controller **$4,995**

4052A Graphic Computing System Controller **$9,900**

4611 Hard Copy Unit **$4,550**

4631 Hard Copy Unit **$5,950**

4662 Interactive Digital Plotter **$2,995**

4924 Digital Cartridge Tape Drive **$2,990**

4932 GPIB Extender **$1,195**

OPTIONAL ACCESSORIES

75 Ω to 50 Ω Minimum Loss Attenuator — Order 011-0112-00 ..... **$60**

Dc Block BNC to BNC — Order 015-0221-00 ..... **$85**

P6201 FET Probe to 900 MHz — Order 010-6201-01 .. **$1,145**

1405 TV Sideband Adaptor — (525/60 Markers) **$5,670**

For more information on the 1405 see page 224.

TR 503 Tracking Generator — **$6,500**

For more information on the TR 503 see page 223.

C-5C Camera — **$530**

TV Trigger Synchronizer — Order 015-0261-01 ..... **$650**

Hard Case (transit) — Order 016-0658-00 ..... **$625**

Soft Case — Order 016-0659-00 ..... **$125**

Lab Cart Model 3 — **$560**

Note: The 490 Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras. Battery pack 016-0270-02 is required for C-50, C-51, C-52 and C-53 cameras.

7L18

Digital Storage and Averaging

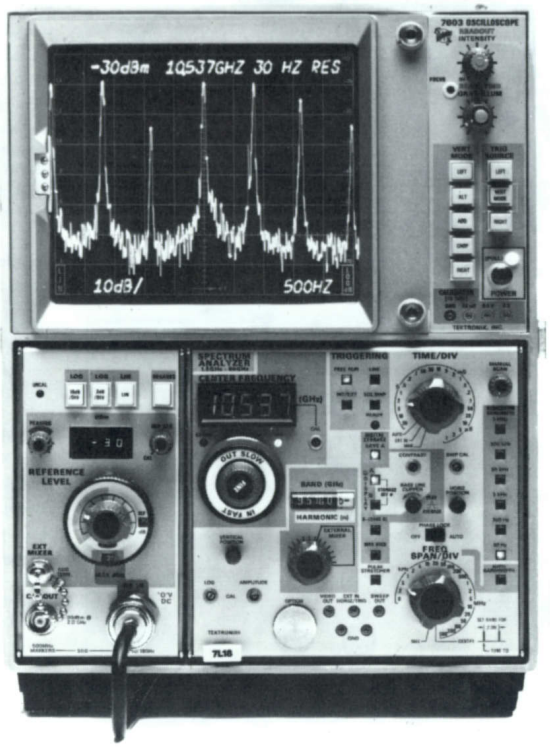
Automatic Phase Lock

Built-In Preselector

30 Hz Resolution to 12 GHz, 300 Hz to 60 GHz with Optional Waveguide Mixers Above 18 GHz

The Tektronix 7L18 makes your most demanding microwave measurements with accuracy and ease. In application after application—microwave relay, ECM, satellite communications and microwave development—the 7L18 is helping make state-of-the-art measurements with the cleanest displays possible.

It delivers close-in 30 Hz resolution to 12 GHz, with ≤10 Hz residual FM peak-to-peak on local oscillator fundamental bands. Amplitude calibration is maintained from 1.5 GHz to 60 GHz for absolute power measurements by using high-performance Tektronix waveguide mixers above 18 GHz. This is the kind of performance you'd expect from a baseband analyzer, but the 7L18 provides it in the microwave spectrum—and does so with versatility and ease typical of our 7000 Series plug-ins. Make high-performance microwave measurements without paying for more frequency coverage than you need.



Digital storage and digital signal processing features all help simplify operation. Max Hold helps you easily measure amplitude or frequency drift, such as oscillator drift resulting from time or temperature change. Digital averaging reduces on-screen noise, which helps you measure low-level signals or spectral purity.

A built-in tracking preselector eliminates spurious responses in all coaxial bands. And for harmonic measurements, it increases dynamic range to 100 dB by rejecting signals outside its bandwidth. If you design, test or evaluate state-of-the-art microwave systems, choose the 7L18 for high performance and 7000 Series versatility.

CHARACTERISTICS

The following characteristics and features apply to the 7L18 Spectrum Analyzer after a warmup period of 30 minutes unless otherwise specified.

FREQUENCY RELATED

Center Frequency

Range — 1.5 GHz to 18 GHz in 5 bands (coaxial input). 12.5 GHz to 60.5 GHz in 6 bands (with ext waveguide mixers).

Readout Resolution — Within 1 MHz with direct input and 10 MHz with waveguide mixers.

Readout Accuracy — ±(5 MHz +20% of frequency span/div) times the oscillator harmonic (n) of the band in use.

Frequency Span — 200 Hz/div to 500 MHz/div in a 1-2-5 sequence.

Accuracy — Within 5% of the span selected over center 8 div.

Linearity — Within 5% over the center 8 div of a 10 div display.

Maximum Span (Depends on Mixing Mode) — Span width = n x 2 GHz where n is the mixing mode. Max span full screen is 8.5 GHz with int mixer (9.5 GHz to 18 GHz band).

Zero Span — Provides fixed frequency operation for time domain display.

Resolution Bandwidth

Range — 30 Hz to 3 MHz, in decade steps plus auto bandwidth.

Accuracy (6 dB Down) — Within 20% of the resolution selected.

Shape Factor (60/6 dB) — 4:1 or less for 3 MHz to 300 Hz; 12:1 or less for 30 Hz resolution.

Residual FM — ≤10 Hz (p-p) x n when phase locked. ≤10 kHz (p-p) x n when not phase locked.

Stability — At a fixed temperature after two hour warmup; within 2 kHz/hour x n when phase locked; within 50 kHz/10 minutes x n when not phase locked.

Tracking Preselector — Internal and Automatic 1.5 GHz to 18 GHz, for rejection of harmonic mixing, image, and multiple responses.

AMPLITUDE RELATED

Display Modes

Log 10 dB/div — Provides 80 dB display dynamic range. Accuracy within ±1 dB/10 dB to 2 dB maximum over 80 dB display dynamic range.

Log 2 dB/div — Provides 16 dB display dynamic range. Accuracy within ±0.4 dB/2 dB to 1.0 dB maximum over any 16 dB range.

LIN — Within 10%, of full screen, over 8 div.

Reference Level — +40 dBm to −110 dBm in 10 dB calibrated steps (+30 dBm is the maximum safe input level).

RF Attenuator — 60 dB range calibrated in 10 dB steps. Accuracy within ±0.3 dB or 1% of dB reading (whichever is greater) to 4 GHz; ±0.5 dB or 2% of dB reading (whichever is greater) from 4 GHz to 18 GHz.

IF Gain Range — 90 dB.

Step Accuracy — ±1 dB/10 dB step to ±2 dB maximum over entire range.

Sensitivity and Frequency Response with Internal Mixers*1

Frequency Range (GHz)	Mixing Mode	Averaged Noise Level (dBm Max)	Worst Case*2 Frequency Response Optimum Peaking (dB Max)
1.5 to 3.5	1−	−119	±1.8
2.5 to 4.5	1+	−119	±1.8
3.5 to 7.5	2−	−109	±2.5
6.5 to 12.5	3+	−107	±4.0
9.5 to 18.0	5−	−92	±4.0

*1 *Averaged noise level specified for 300 Hz resolution bandwidth. Frequency response with 10 dB input attenuator setting.*

*2 *Includes mixer frequency response, RF attenuator frequency response, internal preselector frequency response, mixing mode gain variation, RF input vswr.*

Sensitivity and Frequency Response with External Mixers*1

Frequency Range (GHz)	Mixing Mode	Averaged Noise Level (dBm Max)	Response (dB Max)
12.5 to 18.0	6+	−85	—
18.0 to 26.5*2	7+	−90	±3
26.5 to 40.0*2	10+	−85	±3
40.0 to 60.5*2	15+	−75	±3

*1 *Averaged noise level specified for 3 kHz resolution bandwidth.*

*2 *High performance mixer line.*

SPURIOUS RESPONSES

Residual — ≤−110 dBm, referred to band 1, with no input attenuation and with no signal present at the input. Calibrator related may be −100 dBm.

Intermodulation Distortion — Third order down 70 dB or more from any two full screen signals, when IF gain is not set to gain reduced position (red sector).

Mixed — All harmonic mixing, image, and multiple responses down 70 dB or more to 18 GHz.

GENERAL CHARACTERISTICS

Noise Sidebands — When phase locked, for fundamental conversion (n = 1), −70 dBc minimum at frequency offsets ≥20 X resolution bandwidth settings.

Sweep — Triggered, auto, manual, external.

Sweep Time — 20 s/div to 1 μs/div in a 1-2-5 sequence.

Accuracy — Within 6% of selected time/div.

Triggering Modes — Internal, External, Line, Free Run, Single Sweep.

Sensitivity — 0.5 div internal, 0.5 V external (50 V maximum).

Shipping Weight — 11.7 kg (26 lb).

INPUT SIGNAL CONNECTORS

RF Input — Maximum Input Power Level to the RF Attenuator: 1 W average and 200 W peak. Burnout is 1 W or more at the input. Input Impedance: 50 Ω nominal (1.5 GHz to 18 GHz); Vswr 1.35 maximum with 10 dB of RF attenuation. Input Compression Point: ≥−28 dBm from 1.5 GHz to 1.8 GHz. ≥−18 dBm from 1.8 to 18 GHz (both with zero RF attenuation).

External Horizontal/Trigger Input Connector — Requires 0 V to 10 V ±1 V for 10 div sweep. Requires 0.5 V (p-p) to trigger the sweep circuits. 50 V peak maximum.

OUTPUT SIGNAL CONNECTORS

Cal Out — −30 dBm, ±0.5 dB at 25°C at 2.0 GHz ±0.01%.

Sweep Out and Video Out

INCLUDED ACCESSORIES

Spectrum analyzer graticule (337-1439-01); spectrum analyzer graticule (337-1159-02); BNC female to N male adaptor (103-0045-00); 10 inch 50 Ω coaxial cable (012-0208-00); plug-in to mainframe securing kit (016-0637-00); operators manual; service manual.

ORDERING INFORMATION

7L18 Spectrum Analyzer **$19,400**
7603 Mainframe (shown)*1 ..... **$2,865**
R7603 Mainframe (Rackmount) **$3,285**
Option 06 — Internal SA Graticule ..... +$50
Option 08 — Protective Front Cover (Cabinet Only) ..... +$100
Option 77 — SA Graticule GM (P7) Phosphor and Internal ..... +$100

*1 *Suggested Mainframe: 7603 Option 08/Option 06 for maximum transportability. Has protective front cover (Option 08) and Spectrum Analyzer Graticule (Option 06). See 7000 Series pages for oscilloscope specifications and options.*

OPTIONAL ACCESSORIES

General Purpose Waveguide Mixers Set —
Order 016-0640-00 ..... **$740**
12.4 to 18 GHz Mixer — Order 119-0097-01 ..... **$190**
18 to 26.5 GHz Mixer — Order 119-0098-01 ..... **$290**
26.5 to 40 GHz Mixer — Order 119-0099-01 ..... **$360**
Cable — Order 012-0748-00 ..... **$60**
Case — Order 016-0465-01 ..... **$50**

High Performance Waveguide Mixers —
18 to 40 GHz Set — Order WM490-2 ..... **$2,520**
18 to 60 GHz Set — Order WM490-3 ..... **$4,200**
18 to 26.5 GHz Mixer — Order WM490K **$1,225**
26.5 to 40 GHz Mixer — Order WM490A **$1,225**
40 to 60 GHz Mixer — Order WM490U **$1,680**
Cable — Order 012-0649-00 ..... **$50**
Case — Order 016-0465-01 ..... **$50**

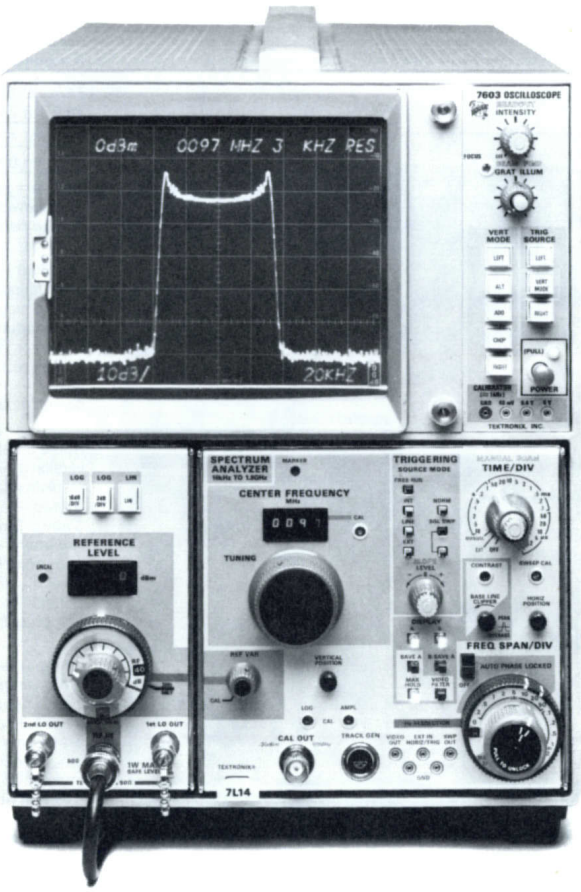
7L14

Digital Storage and Averaging

Automatic Phase Lock

Swept Frequency Measurements with TR 502

Input Limiter for Extra Input Protection



The Tektronix 7L14 is the VHF/UHF member of the 7000 Series Digital Storage Family. It provides high performance in the 10 kHz to 1.8 GHz range. Measurements for RFI/EMI, FM, TV, avionics, navigation, two-way and other communications systems are made with accuracy and convenience.

Resolution bandwidth can be varied from 30 Hz to 3 MHz over the entire frequency range. Automatic phase lock ensures excellent stability—incidental FM is ≤13 Hz p-p. Phase noise sidebands are no greater than −70 dBc at 25 resolution bandwidths away.

All this gives you the critical accuracy necessary for design and proof-of-performance measurements. Check broadband RF networks, filter networks, amplifiers, and more...easily and economically.

Digital storage expands 7L14 capability. You can compare waveforms, such as a filter response to a standard, simultaneously using independent A and B memories. A Max Hold function makes it easy to measure amplitude and frequency drift such as in an oscillator; or capture short duration signals such as in spectrum occupancy monitoring.

An input limiter provides automatic overload protection of the first mixer. Signals up to one watt can be connected to the input for any setting of the RF input attenuator. In addition, the input is ac-coupled for protection from dc and large voltages at line frequency (50/60 Hz). Frequency coverage down to 1 kHz can be obtained by deleting the built-in limiter. Also, by ordering Option 39 you can extend the 7L14's frequency range from 1 kHz to 2.5 GHz. This is useful for satellite communications measurements, on multipoint distribution systems and other terrestrial microwave applications. For details see page 220.

Using the 7L14 with a companion TR 502 Tracking Generator, you can make swept frequency measurements from 100 kHz to 1.8 GHz. For detailed information, refer to page 223.

CHARACTERISTICS

The following characteristics and features apply to the 7L14 Spectrum Analyzer after a warm up period of 20 minutes.

FREQUENCY RELATED

Center Frequency Range — 10 kHz to 1.8 GHz.

Readout Resolution — Within 1 MHz.

Readout Accuracy — ±(5 MHz + 20% of frequency span/div).

Frequency Span — 200 Hz/div to 100 MHz/div in calibrated steps in a 1-2-5 sequence.

Accuracy — Within 5% of the span selected.

Linearity — Within 5% of the span selected.

Maximum Span — Provides 1.8 GHz of span.

Zero Span — Provides fixed frequency operation for time domain display.

Resolution Bandwidth

Range — 30 Hz to 3 MHz, in decade steps.

Accuracy (6 dB down) — Within ±20% of the resolution selected.

Shape Factor (60/6 dB) — 4:1 or less for 3 MHz to 300 Hz; 12:1 or less for 30 Hz resolution.

Signal Level Change Between Any Two Bandwidths — ±0.5 dB at room temperature. ±2.0 dB maximum over temperature.

Residual FM — 13 Hz (p-p) when phase locked ±10 kHz (p-p) for 20 ms when not phase locked.

Stability — At a fixed temperature after two hour warm up; ±2 kHz/hour phase locked; ±75 kHz/hour not phase locked. At constant frequency, wait 10 minutes/GHz of tuning when the frequency is changed.

AMPLITUDE RELATED

Display Modes

Log 10 dB/div — Provides 70 dB display dynamic range.

Accuracy within 0.15 dB/dB to 2 dB maximum over 70 dB dynamic range.

Log 2 dB/div — Provides 14 dB display dynamic range.

Accuracy within ±0.4 dB/2 dB to 1.0 dB maximum over 14 dB dynamic range.

LIN — Within 10% over 8 divisions. Deviation between display modes (for full screen signal): ±2 dB from 2 dB/div to 10 dB/div, 0.5 divisions from 2 dB/div to LIN.

Reference Level

Below 100 kHz — +30 dBm to −50 dBm, as the center frequency approaches 10 kHz.

Above 100 kHz — +30 dBm to −110 dBm in 10 dB calibrated steps.

Display Flatness — ±1.5 dB, with respect to 50 MHz, over any selected frequency span.

Sensitivity — At 50 MHz, applicable from 100 kHz to 1.8 GHz.

Resolution Bandwidth	Averaged Input Noise Level
30 Hz	−130 dBm
300 Hz	−120 dBm
3 kHz	−110 dBm
30 kHz	−100 dBm
300 kHz	−90 dBm
3 MHz	−80 dBm

RF Attenuator — 60 dB range in 10 dB steps.

Accuracy — ±(0.25 dB +1.2% of dB reading).

IF Gain

Range — 70 dB (80 dB when operating in 30 Hz resolution bandwidth).

Step Accuracy — ±1 dB/10 dB step to ±2 dB maximum over entire range.

SPURIOUS RESPONSES

Residual — < −100 dBm (referenced to the 1st mixer input).

Second Order Intermodulation Products — 100 kHz −1.8 GHz; down 70 dBc or more from two −40 dBm signals, within any frequency span.

Third Order Intermodulation Products — 100 kHz −1.8 GHz; down 70 dBc or more from two −30 dBm signals, within any frequency span.

GENERAL CHARACTERISTICS

Noise Sidebands — −70 dBc minimum at frequency offsets ≥25 X resolution bandwidth settings.

Sweep — Triggered, manual, external.

Sweep Time — 10 s/div to 1 μs/div in a 1-2-5 sequence.

Accuracy — ±5% of selected Time/div.

Triggering Modes — Internal, External, Ext in Horiz/Trig and Line.

Sensitivity — ±0.6 div of internal signal (p-p) and/or ±0.6 V (p-p) of external signal.

Shipping Weight — 10.8 kg (24 lb).

INPUT SIGNAL CONNECTORS

RF Input — Maximum Input Power Level: +30 dBm. Maximum Input Power Level to the RF Attenuator ≥10 dB: 1 W average (including dc), 100 W peak simultaneously. Input Impedance: 50 Ω; vswr 1.35 maximum with 10 dB of RF attenuation.

External Horizontal/Trigger Input Connector — Input Voltage Range: Typically 0 V to 10 V for 10 div sweep. Typically 0.5 V (p-p) to trigger the sweep circuits. 40 V peak maximum.

OUTPUT SIGNAL CONNECTORS

Cal Out — −30 dBm, ±0.3 dB at 50 MHz, ±0.01%.

1st Lo Out, 2nd Lo Out, Swp Out and Video Output

ENVIRONMENTAL CHARACTERISTICS

The 7L14 meets its electrical characteristics over the environmental limits per MIL-T-28800 Type 3 Class 6, Style E instruments. The 7L14 is operable over the limits of a MIL-T-28800 Class 5 instrument. The 7L14 is physically and electrically compatible with all Tektronix 7000 Series mainframes.

INCLUDED ACCESSORIES

Spectrum Analyzer Graticule. 6 ft 50 Ω coaxial cable with BNC connectors (012-0113-00); BNC male to female adaptor (103-0058-00); amber light filter (378-0684-01); light filter (378-0625-07); clear plastic implosion shield with Log, Lin, Ref, and F (frequency) direction markings (337-1439-01) for 7603 Oscilloscope and (337-1159-02) for other 7000 Series oscilloscopes, instruction manual.

ORDERING INFORMATION

7L14 Spectrum Analyzer **$17,900**

Option 39 — 1 kHz to 2.5 GHz Extended Frequency Range ..... **+$500**

7603 Mainframe (shown) **$2,865**

R7603 Mainframe (Rackmount) **$3,285**

MAINFRAME OPTIONS

Option 06 — Internal Spectrum Analyzer Graticule ..... **+$50**

Option 08 — Protective Front Cover (Cabinet Only) .. **+$100**

Option 77 — GM (P7) Phosphor and Internal Spectrum Analyzer Graticule ..... **+$100**

Tektronix offers service training classes on the 7L14 Spectrum Analyzer. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

7L12

Automatic Phase Lock

Swept Frequency Measurements with the TR 502

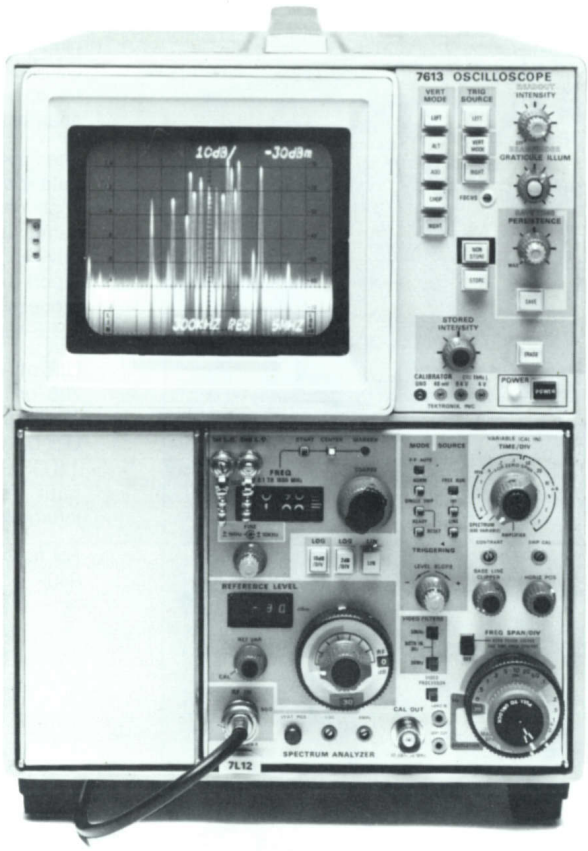
The 7L12 is a popular instrument for use in applications not requiring the resolution, low-end coverage, and digital storage of the 7L14. Resolution bandwidth can be varied from 300 Hz to 3 MHz, with −115 dBm sensitivity at 300 Hz. Automatic phase lock results in good stability; residual FM is ≤200 Hz peak-to-peak.

The 7L12 meets the measurement requirements of many AM, FM, two-way radio and other communications systems. And because it's 7000 Series compatible you get the versatility of using the mainframe of your choice and over 30 test and measurement plug-ins.

The 7L12 has a 70 dB spurious-free display dynamic range; low level noise measurements are made accurately, easily.

Ease-of-use features include fully-calibrated displays and, as with all 7000 Series analyzers, CRT readout of all key parameters. Additional front-end protection is available with a dc block accessory. With its companion TR 502 Tracking Generator, the 7L12 handles swept frequency measurements from 100 kHz to 1.8 GHz. And because the 7L12 is only a "two-wide" plug-in you get time or frequency displays by adding a vertical amplifier plug-in. Choose the 7L12 for economical high-performance in VHF/UHF bands.

Also, by ordering Option 39 you can extend the 7L12's frequency range from 100 kHz to 2.5 GHz. This is useful for satellite communications measurements, on multipoint distribution systems and other terrestrial microwave applications. For details, see page 220.



7L12 with 016-0155-00 Blank Panel in 7613 Option 06 Variable Persistence Mainframe with internal spectrum analyzer graticule.

CHARACTERISTICS

The following characteristics and features apply to the 7L12 Spectrum Analyzer after a warm up period of 40 minutes.

FREQUENCY RELATED

Center Frequency Range — 100 kHz to 1.8 GHz.
Readout Accuracy — ±(8 MHz +1% of dial readout).
Frequency Span — 500 Hz/div to 100 MHz/div in calibrated steps in 1-2-5 sequence.
Accuracy — Within 5% over center 8 div.
Linearity — Within 5% over center 8 div.
Maximum Span — Provides 1.8 GHz of span.
Zero Span — Provides fixed frequency operation for time domain display.
Resolution Bandwidth
Range — 300 Hz to 3 MHz, in decade steps.
Accuracy (6 dB Down) — Within ±20% of the resolution selected.
Shape Factor (60/6 dB) — 4:1 or less.
Signal Level Change Over the Five Bandwidths — <0.5 dB at 20°C.
Residual FM — 200 Hz (p-p) when phase locked. 20 kHz (p-p) maximum in 5 seconds when not phase locked.
Stability — At a fixed temperature after two hour warm up; within 50 kHz/hour phase locked; within 100 kHz/hour not phase locked.

AMPLITUDE RELATED

Display Modes
Log 10 dB/Div — Provides 70 dB display dynamic range.
Accuracy — Within 1 dB/10 dB to 1.7 dB maximum over 70 dB display dynamic range.
Log 2 dB/Div — Provides 14 dB display dynamic range.
Accuracy — Within ±0.4 dB/2 dB to 1.0 dB maximum over 14 dB display dynamic range.
LIN — Within 8% over 8 center div. Deviation between display modes ±2 dB from 2 dB/div to 10 dB/div, 0.5 div from 2 dB/div to LIN.
Reference Level — +30 dBm to −100 dBm in 10 dB steps.
Display Flatness — ±1.7 dB over any selected frequency span, with respect to the display level at 50 MHz.
Sensitivity for a cw Signal — The following sensitivity characteristics apply at 50 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and to 4 dB at 1.8 GHz.

Resolution Bandwidth	Averaged Noise Level
300 Hz	−115 dBm
3 kHz	−108 dBm
30 kHz	−100 dBm
300 kHz	−90 dBm
3 MHz	−80 dBm

SPURIOUS RESPONSES

Residual — <−99 dBm (referenced to the 1st mixer input).
Second Order Intermodulation Products — Down 70 dB or more from two −40 dBm signals, within any frequency span.
Third Order Intermodulation Products — Down 70 dB or more from two −30 dBm signals, within any frequency span.
RF Attenuator — 60 dB range in 10 dB steps.
Accuracy — ±.25 dB or 1.2% of dB reading; whichever is greater.
IF Gain — Range: 70 dB.
Step Accuracy — ±1 dB/10 dB step to ±1.5 dB maximum over entire range.

GENERAL CHARACTERISTICS

Sweep Time — 10 ms/div (Spectrum position) to 1 μs/div are provided in 1-2-5 sequence. A Variable control provides continuous variation between steps. Accuracy within 5%.
Triggering Modes — (P-P) Auto, Norm, Single Sweep.
Sensitivity — ≤0.5 div for the (p-p) Auto mode, ≤0.3 div for the Norm mode, ≤1.5 div for the Single Sweep mode.
Input Signal Connectors
RF Input
Maximum Input Power Level Linear Operation — RF Attenuator at 0 dB: −30 dBm.
Safe Input Levels — RF attenuator at 0 dB: +13 dBm. RF: Attenuator at 60 dB: +30 dBm (1 W average, 100 W peak).
Input Impedance — 50 Ω.
Horizontal Input — Requires a 10 V ±1 V signal.
Output Signal Connectors
Cal Out — −30 dBm, ±0.3 dB at 50 MHz, ±0.01%.
1st LO Out, 2nd LO Out, Vert Out
Shipping Weight — 7.6 kg (17 lb).

INCLUDED ACCESSORIES

Spectrum Analyzer Graticule. Clear plastic implosion shield with LOG, LIN, REF, and f (frequency) direction markings: (337-1439-01) for 7403N and 7603 Oscilloscopes, and (337-1159-02) for other 7000 Series oscilloscopes. Amber light filter (378-0684-01); light filter (378-0625-07); 6 foot 50 Ω coaxial cable with BNC connectors (012-0113-00); BNC Male to N Female adaptor (103-0058-00); instruction manual.

ORDERING INFORMATION

7L12 Spectrum Analyzer **$10,250**
Option 39 — 100 kHz to 2.5 GHz Extended Frequency Range ..... +$500
7613 Variable Persistence Mainframe **$5,330**
R7613 Variable Persistence Mainframe (Rackmount) **$5,750**
Option 06 — Internal S A Graticule ..... +$50
Option 08 — Protective Front Cover (Cabinet Only) ..... +$100
7603 Mainframe **$2,865**
R7603 Mainframe (Rackmount) **$3,285**
Option 06 — Internal S A Graticule ..... +$50
Option 08 — Protective Front Cover (Cabinet Only) ..... +$100
Option 77 — GM (P7) Phosphor and Internal Spectrum Analyzer Graticule ..... +$100
7K11 CATV Preamplifier (page 224) ... **$1,100**
Blank Plug-In Panel Order 016-0155-00 ..... $45

Semiautomatic spectrum analysis can be achieved by using 7000 Series spectrum analyzer plug-ins with the Tek 7854 Waveform Processing Oscilloscope Mainframe. This team brings powerful on-board computing capability to spectrum analysis and measurement.

The 7854 digitally stores and processes spectrum data points to compare several spectra, and implement programmed calculations such as total harmonic distortion, AM percent modulation, FM deviation, and impulse bandwidth. It can also report measurement information to other data processing or recording devices via the GPIB bus (IEEE-488-1978 Standard).

Utilization of the 7854 with the 20 Hz to 5 MHz 7L5 or 1.5 GHz to 60 GHz 7L18 requires minor modification to the plug-ins during manufacture. Using the 10 kHz to 1.8 GHz 7L14 or 100 kHz to 1.8 GHz 7L12 requires no modification. Consult your Tektronix sales engineer for further information.

For further information on the 7854, refer to page 340.

CHARACTERISTICS — 7L14 Option 39, 7L12 Option 39

7L14 OPTION 39

Option 39 extends the 7L14's frequency range from 1 kHz to 2.5 GHz.

FREQUENCY

Range — 1 kHz to 2.5 GHz.

Center Frequency Accuracy — ±(5 MHz +0.5% of center frequency +20% of span/div setting).

AMPLITUDE

Display Flatness — ±1.5 for 10 kHz to 1.8 GHz, with respect to 50 MHz, +1.5, −2.5 for 1.8 GHz to 2.5 GHz.

Spurious Responses

Residual: ≤−95 dBm to 2.5 MHz. ≤−100 dBm for 2.5 MHz to 1.8 GHz. ≤−60 dBm for 1.8 GHz to 2.5 GHz.

Intermodulation Distortion: Third order down 70 dB or more from two −30 dBm signals within any frequency span. Second order down 70 dB or more from two −40 dBm signals.

IF Feedthrough: At least 15 dB down at 2.095 GHz input.

Images: At least 10 dB down at 4.095 GHz to 6.795 GHz.

For Ordering Information and complete 7L14 Characteristics, see page 218.

7L12 OPTION 39

Option 39 extends the 7L12's frequency range from 100 kHz to 2.5 GHz.

FREQUENCY

Range — 100 kHz to 2.5 GHz (Usable below 100 kHz with degraded performance).

Center Frequency Accuracy — ±(8 MHz +1% of dial indication).

AMPLITUDE

Display Flatness — ±1.7 dB for 100 kHz to 1.8 GHz. ±2 dB for 1.8 GHz to 2.5 GHz.

Spurious Responses

Residual: ≤−95 dBm to 2.5 MHz. ≤−99 dBm for 2.5 MHz to 1.8 GHz. ≤−60 dBm for 1.8 GHz to 2.5 GHz.

Intermodulation Distortion: Third order down 70 dB or more from two −30 dBm signals within any frequency span. Second order down 70 dB or more from two −40 dBm signals.

IF Feedthrough: At least 15 dB down at 2.095 GHz input.

Images: At least 10 dB down at 4.095 GHz to 6.795 GHz.

For Ordering Information and complete 7L12 Characteristics see page 219.

7L5

Digital Storage and Averaging

Synthesizer Tuning

Three-Knob Operation

Swept Frequency Measurements with Option 25

Preset Reference Level and Dot Frequency for Extra Input Protection

Selectable Input Impedance

Reference Level Selection in 1 dB and 10 dB Steps

Absolute Calibration in dBm, dBV, or Volts/Div

The Tektronix 7L5 provides lab grade, easy-to-use low-frequency measurement capability. The 7L5 can cover 20 Hz to 5 MHz in one display. Resolution bandwidth can be varied from 10 Hz to 30 kHz, with residual FM of no more than 1 Hz peak-to-peak. Comparing baseband channel performance is easy because the 7L5 switches from a single channel to a 60-channel supergroup without retuning. You see all channel amplitudes at a glance, side-by-side.

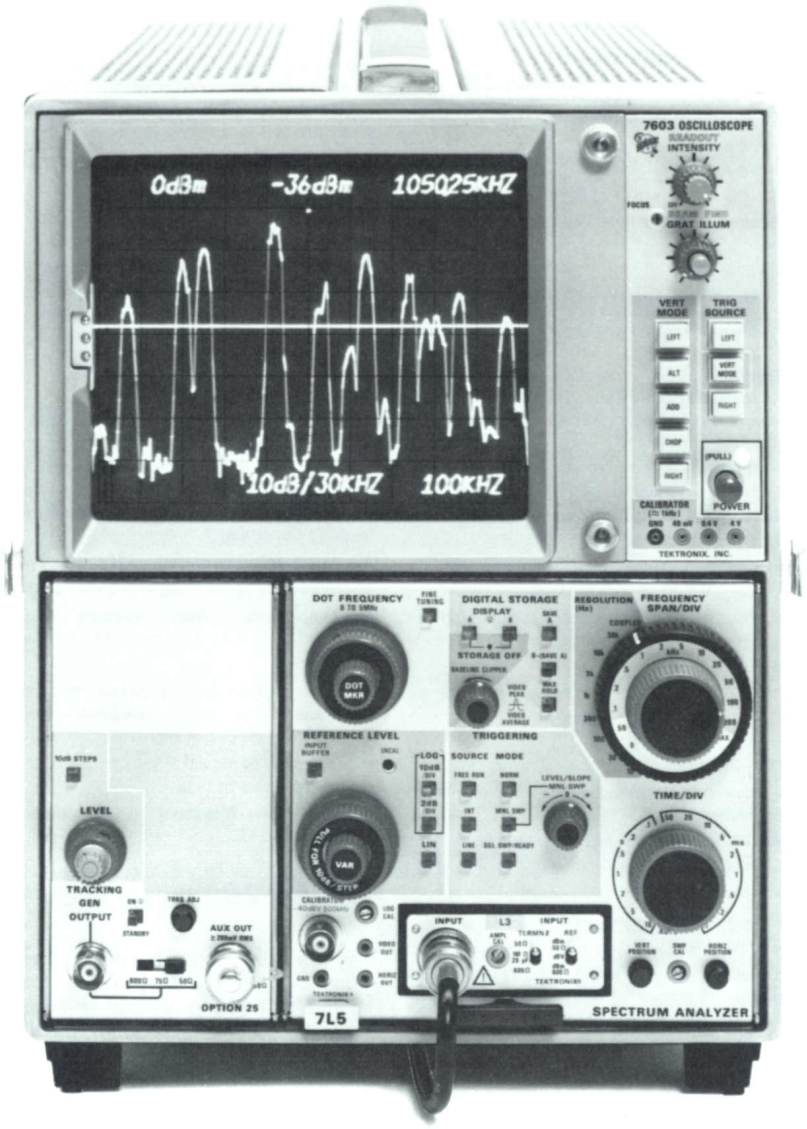
Digital storage proves particularly useful in the 7L5. With digital averaging and peak detection, you can accurately measure low level signals, such as intermodulation distortion products, in the presence of noise. With Max Hold, you can capture short duration signals and random transient phenomena that would otherwise be lost.

The 7L5 combines high performance with easy-to-use three-knob operation —

1) Set frequency span
2) Set center frequency
3) Set reference level...and measure!

Sweep speed and resolution bandwidth are set automatically.

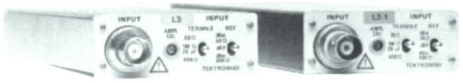
Digital tuning and synthesizer stability let you set center frequency with six-digit accuracy immediately upon turn-on. Reference level can be set in 1 dB and 10 dB steps, eliminating the need to interpolate amplitude levels. And for measuring wide relative amplitude differences, the 7L5 offers 80 dB spurious-free display dynamic range.



7L5 Option 25 Spectrum Analyzer with L3 plug-in module in a 7603 Option 06 mainframe with internal spectrum analyzer graticule

The 7L5 makes accurate baseband communications measurements such as noise, spurious response, distortion, and transient interference, all with the certainty of 10 Hz resolution. The 7L5 Option 25 provides swept frequency measurements from 20 Hz to 5 MHz. The tracking generator is built into a "three-wide" 7L5 plug-in analyzer.

This highly capable audio/baseband analyzer finds a place in many areas of use, including measurement of communications system basebands, power line distortion, EMI/RFI, and computer systems.



Probe-compatible plug-in input modules provide a variety of impedances for the 7L5. The L3 may be switch-selected to 50 Ω, 600 Ω or 1 MΩ. The L3 Option 01 is switch-selectable to 75 Ω, 600 Ω or 1 MΩ.

CHARACTERISTICS

The following characteristics and features apply to the 7L5 Spectrum Analyzer after a warm-up period of 10 minutes.

FREQUENCY RELATED

Center Frequency

Range — Input frequency range is 20 Hz through 5.0 MHz. Dot frequency range is 0 Hz through 4999.75 kHz tuned in 10 kHz or 250 Hz steps.

Accuracy — 0°C to 50°C: ±(20 Hz + 10^{-5} of dot frequency). 20°C to 30°C: ±(5 Hz + 2 x 10^{-6} of dot frequency).

Frequency Span — 50 Hz/div to 500 kHz/div (maximum) in a 1-2-5 sequence.

Accuracy — Within 5%.

Linearity — Within 5% over the center 8 divisions.

Zero Span — Provides fixed frequency operation for time domain display.

Resolution Bandwidth

Range — 10 Hz to 30 kHz in 8 steps. Coupled position electronically couples resolution to span/div selection so that both are controlled by the same knob.

Accuracy (6 dB Down) — Within 20% of resolution selected (30 Hz to 30 kHz). 10 Hz is 100 Hz ±20 Hz 70 dB down.

Shape Factor (60/6 dB) — 10:1 or better for 10 Hz to 1 kHz and 5:1 or better for 3 kHz to 30 kHz.

Signal Level Change Between Any Two Bandwidths — 30 kHz to 100 Hz: ≤0.5 dB. 30 kHz to 10 Hz: ≤2.0 dB.

Residual FM — ≤1 Hz (p-p) for frequency span of 50 Hz/div to 2 kHz/div. ≤40 Hz (p-p) for frequency span of 5 kHz/div to 500 kHz/div.

Stability — ≤5 Hz/hour.

AMPLITUDE RELATED

Display Modes

Log 10 dB/Div — Provides 80 dB display dynamic range.

Accuracy — Within 0.08 dB/dB to 2 dB maximum over 80 dB display dynamic range.

Log 2 dB/Div — Provides 16 dB display dynamic range.

Accuracy — Within 0.15 dB/dB to 1 dB maximum over 16 dB display dynamic range.

LIN — 20 nV/div to 200 mV div in a 1-2-5 sequence.

Accuracy — Within 5%.

Reference Level — +21 dBm to −128 dBm (50 Ω or 75 Ω input impedance), +10 dBm to −139 dBm (600 Ω input impedance), +8 dBV to −141 dBV (1 MΩ input impedance). Calibrated in 1 dB and 10 dB steps.

Display Flatness — 0.7 dB maximum from 20 Hz to 5 MHz, (add 0.5% quantization error in digital storage).

Sensitivity — Equivalent input noise for each resolution bandwidth setting is measured in video average mode with 10 s/div sweep rate and input buffer control off. Sensitivity is degraded an additional 8 dB when the input buffer is on.

Resolution Bandwidth	Averaged Noise Level
10 Hz	−148 dBV
30 Hz	−146 dBV
100 Hz	−143 dBV
300 Hz	−138 dBV
1 kHz	−133 dBV
3 kHz	−128 dBV
10 kHz	−123 dBV
30 kHz	−118 dBV

Spurious Responses

Residual — ≤ −143 dBV (noncalibrator related, referenced to the input).

Intermodulation Products — Within any frequency span for two on screen signals of any input level, third order down 75 dB or more and second order down 72 dB or more; of any input level up to −53 dBV or of any input level with input buffer on, second and third order down 80 dB or more.

GENERAL CHARACTERISTICS

Sweep — Triggered, manual, auto.

Sweep Time — 10 s/div to 0.1 ms/div in a 1-2-5 sequence.

Accuracy — Within 5% of selected time/div.

Triggering — Sources are free run, internal and line. Modes are normal, manual sweep and single sweep.

Sensitivity — ≥1.5 div of internal signal for both normal and single sweep modes over the approximate frequency range of 30 Hz to 500 kHz.

Shipping Weight — 7.6 kg (17 lb).

INPUT SIGNAL CONNECTORS

MAXIMUM INPUT POWER LEVEL

1 MΩ/28 pF — 15 V (p-p) for ac or pulse signals with risetimes of 2 V/μs or faster (pulses or ac beyond this specification may open an input fuse). 40 V (dc plus peak ac) for signals with risetimes slower than 2 V/μs.

600 Ω (Internally Terminated) — 12 V dc or RMS (+24 dBm).

50 Ω (Internally Terminated) — 3.5 V dc or RMS (+24 dBm).

Input Impedance — Switch selectable 1 MΩ in parallel with 28 pF, 50 Ω (75 Ω for L3 Option 01) termination, or 600 Ω termination.

OUTPUT SIGNAL CHARACTERISTICS

Calibration — 500 kHz squarewave within ±0.15 dB of −40 dBV into the plug-in impedance.

Video Out — 50 mV/div ±5% (about the CRT center) with source impedance of 1 kΩ.

Horizontal Out — 0 to about −6 V dc sawtooth with a source impedance of 5 kΩ.

Option 25 TRACKING GENERATOR

The 7L5 with Option 25 Tracking Generator, provides selectable 50 Ω, 75 Ω, or 600 Ω impedance source that has a calibrated output level for swept frequency tests from 20 Hz to 5.0 MHz. The output frequency can be adjusted so it tracks within 10 Hz of the spectrum analyzer frequency. The frequency span and rates are controlled with the spectrum analyzer. The output level is controlled from the tracking generator. Output level is calibrated and controlled in 10 dB and 1 dB steps over a 63 dB range. An Aux Output may be used to drive a frequency counter. The 7L5 with Option 25 is a three-wide unit for the 7000 Series mainframes.

CHARACTERISTICS

Frequency Range — 20 Hz to 5.0 MHz.

Output Impedance — 50 Ω, 75 Ω, or 600 Ω selected by a front panel switch.

Amplitude — The output level is calibrated in dBm or dBV and selectable in 10 dB or 1 dB steps. A vernier provides continuous variation between calibrated steps.

Range — 50 Ω: 0 dBm to −63 dBm. 75 Ω: −6 dBm to −69 dBm. 600 Ω: −17 dBm to −80 dBm.

Accuracy (Maximum Output Calibrated at 500 kHz) — 50 Ω: 0 dBm ±0.25 dB. 75 Ω: −6 dBm + 0.4, −0.2 dB. 600 Ω: −17 dBm +0.5, −0.1 dB.

Attenuator — Range: 0 dB to 63 dB in 10 dB or 1 dB steps. Accuracy: Within 0.2 dB/dB to a maximum of 0.25 dB/10 dB absolute.

Flatness — 50 Ω and 75 Ω: Within 0.5 dB p-p. 600 Ω: Within 1.0 dB p-p. Total System Flatness (7L5 with L3 Plug-in Module and Option 25) 50 Ω and 75 Ω: Within 1.0 dB p-p. 600 Ω: Within 1.25 dB p-p.

Dynamic Range (7L5 with Option 25) — ≥110 dB.

Residual FM (p-p) — Spans to 2 kHz/Div: 2 Hz (7L5 with Option 25). Spans 5 kHz/Div or Greater: 40 Hz (7L5 with Option 25).

Stability — 25 Hz/5 minutes after 10 minute warm-up decreasing to 25 Hz/hour maximum after 1 hour.

Spurious Suppression, 20 Hz to 5.0 MHz (Harmonic and Nonharmonic) — 40 dB or more with respect to the carrier.

Auxiliary Output — ≥200 mV RMS into 50 Ω.

INCLUDED ACCESSORIES

Spectrum Analyzer Graticule (337-1159-00); (7000 Series), and (337-1439-01); (7603), light blue filter (378-0684-00); operators manual; service manual.

ORDERING INFORMATION

7L5 Spectrum Analyzer (Requires L3 Plug-in Module) **$10,200**

Option 25 — Tracking Generator ..... **+$1,500**

For a separate tracking generator (one-wide field modification to be attached to an existing 7L5).
Order 040-0810-00 ..... **$1,850**

L3 Plug-in Module (1 MΩ, 50 Ω, 600 Ω) **$1,550**

Option 01 — L3 Plug-in Module (1 MΩ, 75 Ω, 600 Ω) ..... **NC**

7603 Mainframe **$2,865**

R7603 Mainframe (Rackmount) **$3,285**

Option 06 — Internal S A Graticule ..... **+$50**

Option 08 — Protective Front Cover (Cabinet Only) ..... **+$100**

Option 77 — GM (P7) Phosphor and Internal SA Graticule ..... **+$100**

7704A*[1] Oscilloscope **$4,520**

R7704*[1] Oscilloscope **$7,510**

[1] Suggested Mainframe. See 7000 Series pages for oscilloscope specifications and options.

OPTIONAL ACCESSORIES

Tracking Generator — one-wide field modification kit, to be attached to an existing 7L5.
Order 040-0810-00 ..... **$1,850**

75 Ω to 50 Ω Minimum Loss Attenuator — (Ac coupled).
Order 011-0112-00 ..... **$60**

P6105 10X Probe (2 m) — Order 010-6105-03 ..... **$110**

BALANCED INPUT TRANSFORMER

Frequency Range — 50 kHz to 3 MHz, usable from 10 kHz to 20 MHz.

Flatness — 0.25 dB p-p maximum (50 kHz to 3 MHz) including nominal 0.1 dB insertion loss.

Common-Mode Rejection — 25 dB minimum (50 kHz to 3 MHz).

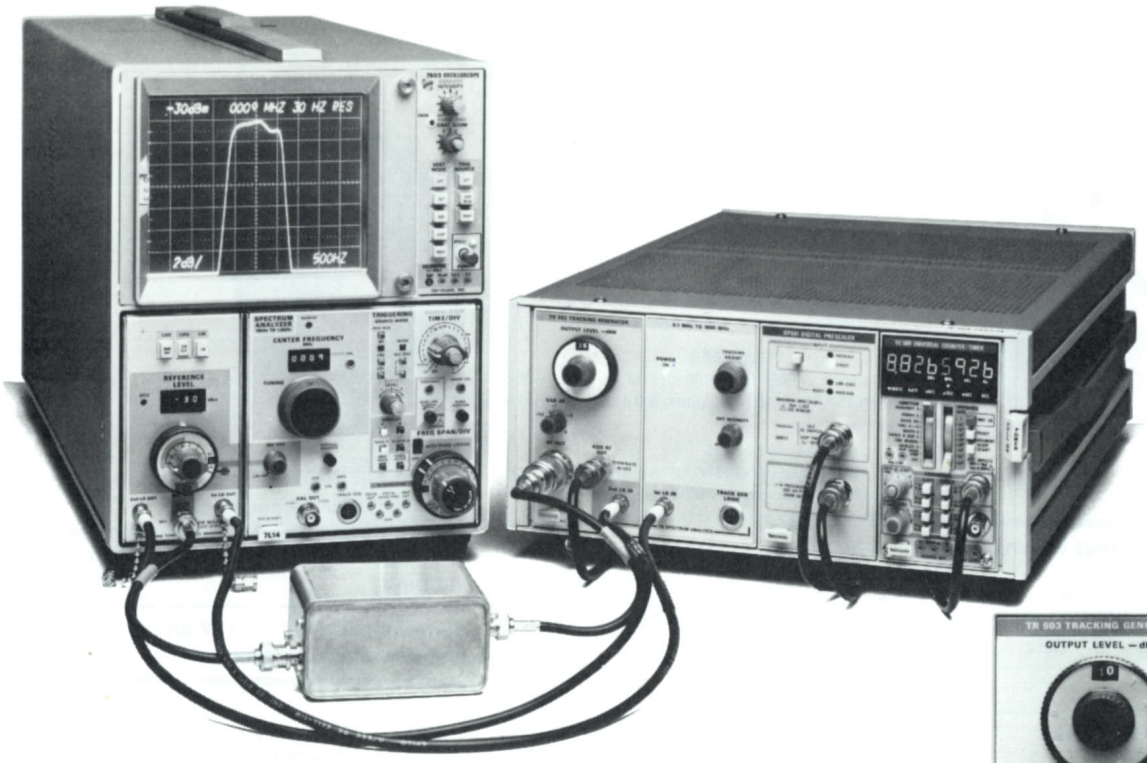
Output Termination — Switchable between 124 Ω, 135 Ω, and None for bridging or external termination.

Connectors — WECO (0.37 in with 0.090 center) on 0.625 in spacing for balanced input. BNC for single-ended output.

Balanced Input Transformer Order 013-0182-00 ..... **$285**

Limited quantities of the 5L4N Spectrum Analyzer are still available. Call your nearest Spectrum Analyzer Sales Engineer for information.

Tektronix offers service training classes on the 7L5 Spectrum Analyzer. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.



For swept frequency tests and precise frequency measurements, the TR 502 Tracking Generator may be used with a DP 501 Digital Prescaler and DC 509 Option 01 Digital Counter, in a TM 504 Power Module. The TR 502 is linked to the 1st and 2nd LO of a 7L14 Spectrum Analyzer in a 7603 mainframe.

TR 502/TR 503 Tracking Generators

Swept Frequency Measurements to 1.8 GHz

The TR 502 works with the 7L12 and 7L14 and the TR 503 works with the 492/492P or 496/496P Spectrum Analyzers to provide constant level, calibrated RF sources for swept frequency tests to 1.8 GHz.

The low residual FM of these systems enhances narrow bandwidth frequency response measurements. When used as a cw signal source with the analyzer in a manual mode, these systems have excellent frequency stability.

The tracking generators are two-wide units compatible with the TM 500 Modular Instrument Series.

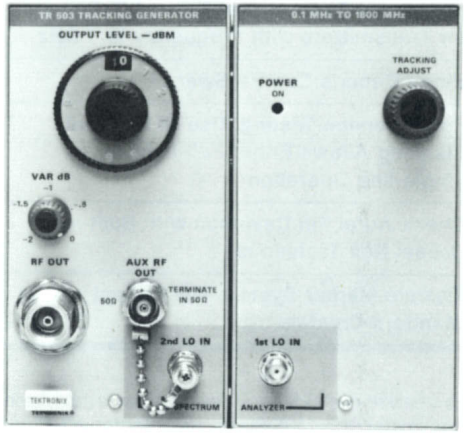
The TR 502/TR 503 Aux RF Output may be used to drive a frequency counter. Frequencies up to 1.8 GHz may be measured accurately in the presence of high level adjacent signals to the sensitivity limits of the analyzer.

The tracking generator sweep rates are controlled with the spectrum analyzer, and the output level is controlled from the tracking generator. The output frequency of the tracking generator is the same as the frequency of the analyzer at any instant of the sweep.

Dot marker frequency measurement capability may be obtained with the TR 502/7L14 spectrum analyzer. For more information concerning the dot marker capability, contact your local Tektronix sales engineer.

CHARACTERISTICS

	TR 503/492/492P/496/496P	TR 502/7L14	TR 502/7L12
Frequency Range	100 kHz −1.8 GHz	100 kHz −1.8 GHz	100 kHz −1.8 GHz
Output Level	(Maximum) 0 dBm ±0.5 dB	0 dBm ±0.5 dB	0 dBm ±0.5 dB
Range	0 to −59 dB in 10 dB and 1 dB steps	0 to −59 dB in 10 dB and 1 dB steps	0 to −59 dB in 10 dB and 1 dB steps
Flatness	Within ±2.25 dB Max from 100 kHz to 1.8 GHz (Typically ±1.5 dB)	Within ±2 dB maximum from 100 kHz to 1.8 GHz (Typically ±1.5 dB)	Within ±3.0 dB maximum from 100 kHz to 1.8 GHz (Typically ±2.0 dB)
Dynamic Range	≥110 dB	≥110 dB	≥100 dB
Residual FM	50 Hz p-p	13 Hz p-p	200 Hz p-p
Output Impedance	50 Ω Nominal, VSWR 2:1 or less to 1.8 GHz	50 Ω nominal, VSWR 2:1 or less to 1.8 GHz	50 Ω nominal, VSWR 2:1 or less to 1.8 GHz
Auxiliary Output	0.1 V into 50 Ω load −7 dBm minimum	0.1 V RMS into 50 Ω Load	0.1 V RMS into 50 Ω Load
Spurious Signoff	Harmonic: −20 dBc Nonharmonic: −40 dBc	Harmonic: 20 dBc Nonharmonic: 40 dBc	Harmonic: 20 dBc Nonharmonic: 40 dBc



OUTPUT CONNECTORS

RF Out — 0 dBm to −61 dBm signal source that tracks input frequency of spectrum analyzer. Output level is set by Output Level control and Var dB control.

Aux RF Out — For use with frequency counter.

INCLUDED ACCESSORIES

TR 502: Two 50 Ω coaxial cables (012-0649-00); logic interface cable (012-0648-00); N male to BNC female adaptor (103-0045-00); retainer plug-in (343-0604-00); 3 mm male to BNC female adaptor (015-1018-00); instruction manual.

TR 503: Two 28.5 inch 50 Ω coaxial cables (012-0649-00); N male to BNC female adaptor (103-0045-00); retainer plug-in (343-0604-00); instruction manual.

ORDERING INFORMATION

TR 502 Tracking Generator **$6,500**

SUGGESTED COMPLEMENTARY ITEMS

TM 504 — Power Module **$375**

DP 501 — Digital Prescaler **$500**

DC 509 Option 01 — Digital Counter with High Stability Time Base **$1,925**

Blank Panel — Order 016-0195-03 ..... **$25**

10 dB, 3 mm Attenuator — Used in the 2nd LO input line to improve TR 502/7L12 isolation Order 307-0553-00 ..... **$44**

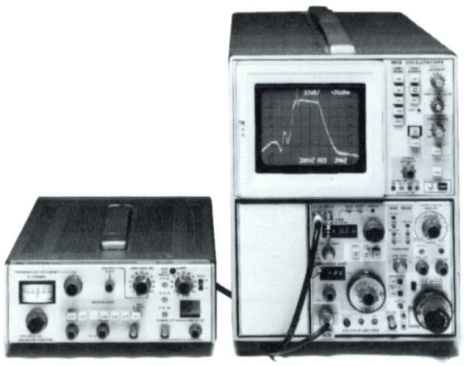
TR 503 Tracking Generator **$6,500**

SUGGESTED COMPLEMENTARY ITEMS

TM 503 — Power Module **$340**

DC 509 Option 01 — Digital Counter with High Stability Time Base ..... **+$2,230**

Blank Panel Order 016-0195-03 ..... **$25**



1405/7L12 TV Sideband Analyzer System

1405 TV Sideband Adaptor

Response of Transmitter Under Test Within ±0.2 dB

Frequency Response of RF and IF Circuits for Transmitters with Frequency to 1 GHz

Video Circuits Can Be Swept

For In-service Testing, Use of External Blanking Allows Either Full-field or Single-line Operation

Check Aural Fm Deviation with Built-in Bessel Null Technique

Flexible Marker System Will Accept Standard Crystals

To analyze the sideband response of a television transmitter, the 1405 Sideband Adaptor is recommended for use in tandem with the Tektronix 7L12, 7L14, 496 and 492 Spectrum Analyzers. It generates a composite video signal, which is applied as modulation to a television transmitter. The output is displayed on the spectrum analyzer and appears as a response curve, to within ±0.2 dB, of the transmitter being tested.

The 1405/Spectrum Analyzer combination will display frequency-response characteristics of RF and IF circuits for transmitters with frequencies to 1 GHz. Video circuits can also be analyzed.

Option 02 provides the correct frequencies at the TV Channel marks on the dial readout so that it is ready for use with the 490 Series spectrum analyzers when shipped from the factory.

CHARACTERISTICS

The following characteristics apply to the 1405, 1405/7L12 or 7L14 combination and 1405/492 or 496 combination. They are applicable over the environmental specification limits for the 1405 and 7000 Series mainframes.

FREQUENCY (FREQUENCY OFFSET)

Range — Will tune and provide a swept video output for a center frequency range of 0 GHz to 1 GHz.

Frequency Dial Accuracy — Dial reading is within 10 MHz of transmitter frequency when properly tuned.

Fine Tuning Range — From ±0.5 MHz to ±1.25 MHz, depending upon transmitter frequency setting.

Tuned Frequency Drift — <1 MHz/hour after a 30 minute warm-up.

OUTPUT SIGNAL LEVEL

Amplitude (Sync Off) — 100 IRE equals 0.714 V p-p when terminated in 75 Ω.

Output Impedance — 75 Ω ±1% at 100 IRE and ±2% from 0 IRE to 90 IRE.

Variable — 0 to 100 IRE in 10 IRE steps.

Accuracy (at 200 kHz) — ±1 IRE at 100 IRE; ±2 IRE from 10 IRE to 90 IRE.

Output Level During Blanking — 0 V ±0.01 V at 0 IRE; 0 V ±0.04 V at 100 IRE from 0 MHz to 1 MHz; 0 V ±0.02 V at 100 IRE above 1 MHz.

Cw Output Harmonics — Third harmonic content down 40 dB from 0.1 MHz to 5 MHz; down 35 dB from 5 MHz to 10 MHz.

FLATNESS

1405 — Within ±0.1 dB from 100 kHz to 10 MHz, within ±0.2 dB from 10 MHz to 15 MHz, within ±0.4 dB from 50 kHz to 20 MHz.

1405 Plus 7L12, 7L14, 492 or 496

For Transmitter Frequency >20 MHz: Within ±0.2 dB from 100 kHz to 10 MHz of picture carrier, increasing to ±0.3 dB at 15 MHz; within ±0.5 dB from 50 kHz to 20 MHz.

For Transmitter Frequency of 0 MHz to 20 MHz: Within ±0.5 dB from 100 kHz to 15 MHz.

System Span — ⩾200 kHz/div.

Video Frequency Range — 15 MHz to 0 MHz to 15 MHz.

APL (AVERAGE PICTURE LEVEL)

Variable — 0 IRE to 100 IRE in 10 IRE steps.

Accuracy — ±2 IRE.

Three Preset Levels — Preset A: 0 IRE to 50 IRE. Preset B: 25 IRE to 75 IRE. Preset C: 50 IRE to 100 IRE.

Horizontal Sync, Blanking, and Pedestal Duration — Within NTSC (PAL — Option 01) limits (no vertical interval is provided). Transition time is 0.24 μs ±10%, from 10% to 90% points.

Composite Sync Source Blanking — 0 V turns cw on > −5 V turns cw off.

Line Strobe — TTL pulse from 0 V to 5 V turns cw on.

AURAL OUTPUT

Output Frequency — 10.396 kHz: ±0.01% (crystal controlled). Option 01: 9.058 kHz.

Cw Output — Amplitude variable up to ⩾+12 dBm into 600 Ω. Harmonics down 45 dB or more.

Crystal Requirements — Series Resonant: R_1 <2000 Ω; Q >5000; Case, HC/6U or HC/25U.

MARKER CRYSTAL INSTALLATION

Because of the various international standards, the 1405 Option 01*1 is shipped with the marker crystals installed. Frequencies installed are 0.75, 1.25, 2.25, 4.43, 5.00, and 5.75 MHz. Additional crystals are shipped with the unit.

*1 *Option 01 instruments are connected for a nominal power line voltage of 240 V. They are furnished with the standard North American plug unless Options A1, A2, A3, A4, or A5 is specified.*

ORDERING INFORMATION

1405 TV Sideband Adaptor
525/60 Markers **$5,670**

Option 01 — TV Sideband Adaptor (625/50 Markers) . **+$200**

Option 02 — (Dial readout for Use with 490 Series) ..... **NC**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 250 V/10 A, 50 Hz

OPTIONAL ACCESSORIES

Rackmount-Conversion Kit For Mounting 1405 or 1405 Option 01 in standard 19 in rack —
Order 016-0489-00 ..... **$400**

7K11 CATV Preamplifier

75 Ω Input Impedance and Calibration in dBmV

Extra Sensitivity for CATV and Field Intensity Measurements

This 7000 Series plug-in preamplifier is for use with the 7L12 or 7L14 and tailored to CATV and field intensity measurement applications, where extra sensitivity is required for demanding measurements. The 7K11 handles 12 channels without overload.

The 7K11 provides a 75 Ω input impedance and calibration in dBmV. Its low noise figure makes it especially suitable for signal-to-noise and low-level radiation measurements.

CHARACTERISTICS

(with 7L12 or 7L14)

Frequency Range — 30 MHz to 890 MHz.

Display Flatness — ±1.0 dB, with respect to the level at 50 MHz over the frequency range of 50 MHz to 300 MHz; increasing to +2.0 dB, −2.5 dB over the full frequency range.

Sensitivity — Signal + noise = 2X noise, in Lin mode at 50 MHz. −90 dBmV at 30 Hz, −80 dBmV at 300 Hz, −73 dBmV at 3 kHz, −65 dBmV at 30 kHz, −55 dBmV at 300 kHz, −45 dBmV at 3 MHz. Noise figure is ⩽5 dB.

Intermodulation Distortion (with 7L12 or 7L14) — Imd products and harmonics from two signals within the frequency range are 70 dB or more down from the reference level for third order intermodulation with two signals at the reference level (full screen).

Reference Level — Calibrated level in 1 dB steps from +79 dBmV to 0 dBmV. Accuracy is referenced to the +30 dBmV calibrator at 50 MHz.

Input Impedance — 75 Ω.

Calibrator — 50 MHz ±0.01% with an absolute amplitude level of +30 dBmV ±0.3 dB, from 75 Ω.

INCLUDED ACCESSORIES

5.5 inch BNC to BNC 50 Ω Cable (012-0057-02); BNC to F Adaptor (013-0126-00); 42 inch BNC to BNC 75 Ω Cable (012-0074-00); instruction manual.

Order 7K11 CATV Preamplifier $1,100

PADS AND ADAPTORS

75 Ω to 50 Ω Minimum Loss Attenuator with dc block, 5.7 dB loss. Order 011-0112-00 ..... **$60**

75 Ω to 50 Ω Matching Attenuator with 11.25 dB conversion factor from dBm to dBV with dc block. Order 011-0118-00 ..... **$60**

Fixed 10 dB Attenuator with 3 mm fittings for use with TR 502 with 7L12. Order 307-0553-00 ..... **$44**

Dc Block BNC to BNC maximum dc potential 50 volts. Order 015-0221-00 ..... **$85**

"F" Female to BNC Male Adaptor Order 013-0126-00 .. **$16**

BNC Female to "F" Male Order 103-0158-00 ..... **$8.50**

Calibrator Jumper 50 Ω BNC to BNC 5.5 in. Order 012-0214-00 ..... **$40**

Jumper Cable BNC to BNC 50 Ω 42 in Order 012-0057-01 ..... **$17**

Jumper Cable BNC to BNC 75 Ω, 42 in. Order 012-0074-00 ..... **$17**

"N" Female to BNC Male Order 103-0058-00 ..... **$7.00**

PROTECTIVE VINYL COVERS

For extra protection in field environments, soft vinyl covers are available to fit over the entire cabinet model mainframe.

7000 Series 3 Hole Mainframe Cover Order 016-0192-01 ..... **$20**

7000 Series 4 Hole Mainframe Cover Order 016-0531-00 ..... **$20**

5000 Series Mainframe Cover Order 016-0544-00 ..... **$25**

RIGID FRONT COVERS

Solid snap on or friction fit covers are available to protect the instruments in transit or field use.

See appropriate spectrum analyzer and mainframe ordering information regarding the Option 08 Protective Front Cover for 7603 and 7613.

Protective Front Cover for existing 7603 or 7613 Mainframes:

Blue Order 040-0835-00 ..... **$175**

Gray Order 040-0628-00 ..... **$180**

GRATICULES, FILTERS

Plastic Implosion Shield and S A Graticule 7613 and 7623 Mainframes. Order 378-0625-07 ..... **$9.50**

Plastic Implosion Shield and S A Graticule 7403 and 7603 Mainframes. Order 337-1439-01 ..... **$8.00**

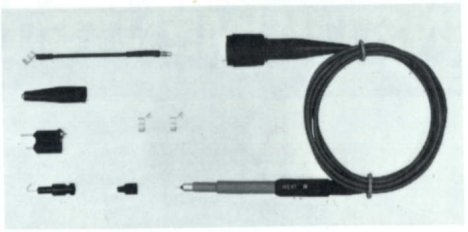
Plastic Implosion Shield and S A Graticule for all other 7000 Series Mainframes. Order 337-1159-02 ..... **$8.00**

(Internal graticules are available with most 7000 Series mainframes)

EMC Metal Screen Mesh Filter for 7500, 7700, 7800, 7900 Series and 7613, 7623, 7633 instruments. Order 378-0603-00 ..... **$55**

EMC Metal Screen Mesh Filter for 7400 Series and 7603 instruments Order-0696-00 ..... **$55**

Complete selection of colored filters is available in the accessories section.



PROBES

A variety of probes is available in varying frequency and impedance ranges that can be used with the 7L5, 7L12, 7L14, 492 and 496 Spectrum Analyzers.

FET Probe P6201 to 900 MHz. Order 010-6201-01 ... **$1,145**

FET Probe P6202A to 500 MHz. Order 010-6202-03 ... **$615**

Conventional Probe P6056 Dc to 3.5 GHz 6 ft. Order 010-6056-03 ..... **$165**

Conventional Probe P6057 Dc to 1.4 GHz with adaptor. Order 010-6057-03 ..... **$170**

Current Probe P6022 to 150 MHz. Order 015-0135-00 **$360**

Complete specifications are available in the probes and accessories section, page 438.

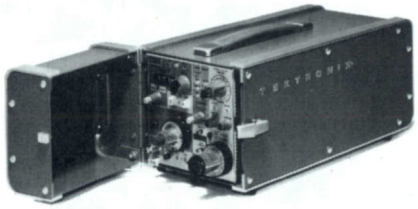
CAMERAS

A camera can greatly enhance the versatility of a spectrum analyzer. Many different units are available. However, the most popular units for the 7000 and 490 Series Spectrum Analyzers are:

Polaroid Film Pack C-59AP **$1,275**

C-5C Camera **$530**

Complete specifications on all cameras are available in the Camera section, page 424.



CARRYING CASES AND MOUNTS

Specialized carrying cases are available in 2 forms to protect your spectrum analyzer.

Metal carrying cases are available for the 7L5, 7L12, 7L14 or 7L18 Plug-in units.

Military style fiberglass and foam type transit cases can be custom fitted to many of the instruments.

A special mounting bracket assembly can be fitted to bolt the analyzer securely into the mainframe if desired.

Securing Kit fits 7L12 or 7L14. Order 016-0637-00 ..... **$50**

3-wide Carrying Case for 7L14, 7L5 Option 25, 7L18. Order 016-0626-00 ..... **$330**

2-wide Carrying Case for 7L12, 7L5. Order 016-0625-00 ..... **$290**

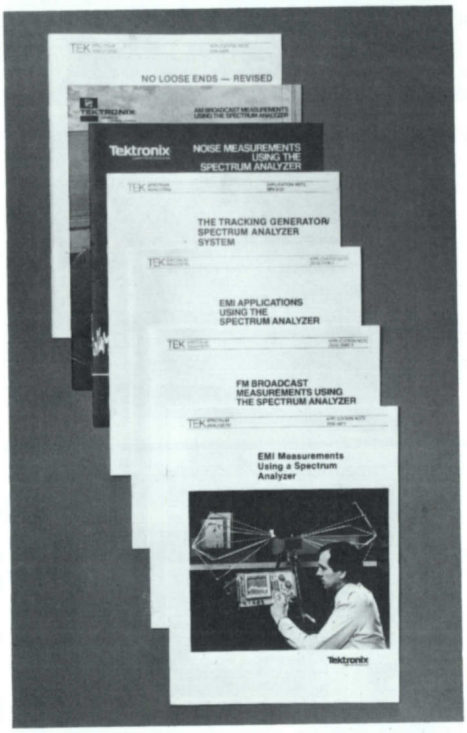
Luggage-type Carrying Case for 7603 Option 08, 7613 Option 08. Order 016-0628-00 ..... **$500**

(Analyzer must have 016-0637-00 Securing Kit) **$50**

Hard Case (transit) for the 490 Series. Order 016-0658-00 ..... **$625**

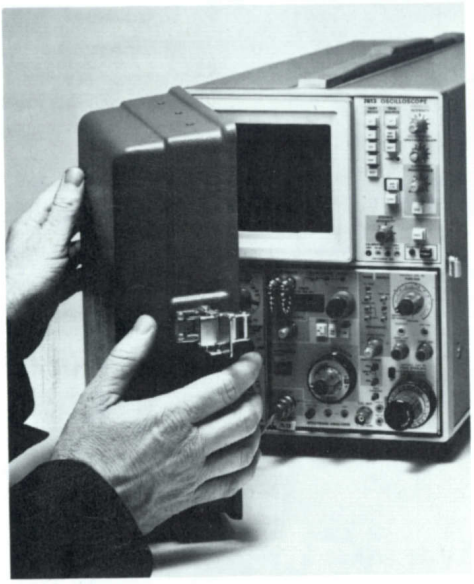
Soft Case for the 490 Series. Order 016-0659-00 ..... **$125**

Your local Sales Office or representative can quote prices and availability on any of these accessories.



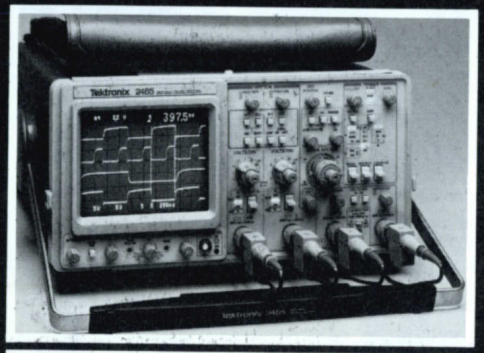
Numerous application notes and magazine article reprints on spectrum analyzer measurements are available. Notes on baseband, EMC, AM, FM, two-way radio and television measurements, audio amplifier testing, noise and pulse testing, and others have been written to help you with your measurements.

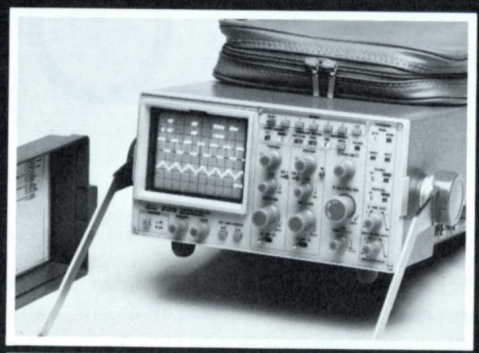
In addition, our staff of specialists stands ready to help you solve any special measurement problems. Contact your local Tektronix Sales Office or representative.



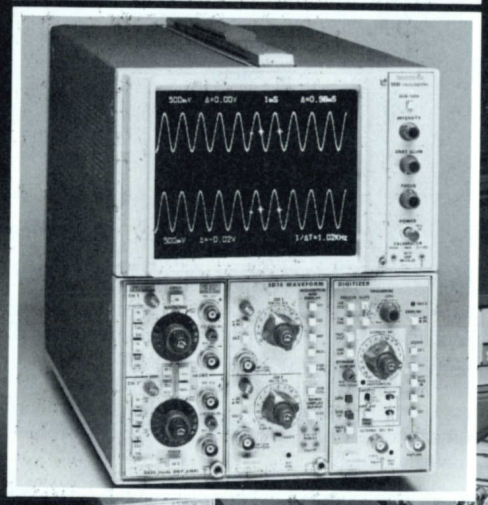
Option 08 protective front cover is shown with 7613 mainframe.

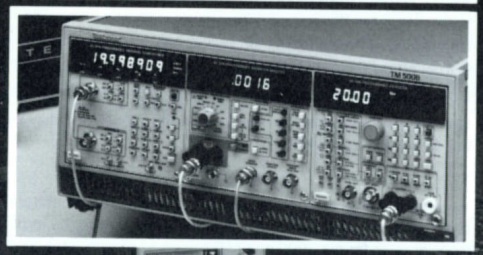
INSTRUMENTS GROUP





Tektronix is pleased to present the world's broadest selection of portable and laboratory oscilloscopes, programmable and manual general-purpose instruments, waveform digitizing instruments and systems, and accessories to meet your instrumentation needs. Some of the many products new to this catalog include the 336 Digital Storage Oscilloscope, 2465 300 MHz Portable Oscilloscope, 5116 Color Oscilloscope, AA 5001/SG 5010 Audio Test System, and the 7A42 Logic-Triggered Vertical Amplifier.





CONTENTS

Page

Laboratory Oscilloscopes 236
7000 Series Instruments 237
7000 Series Nonstorage Mainframes 243
7000 Series CRT Storage Mainframes ... 255
7000 Series Plug-ins 262
7000 Series High Performance Digitizers 336
5000 Series Instruments 284

Portable Oscilloscopes 298
Portable Nonstorage Scopes 301
Portable Storage Scopes 320

Signal Processing Systems 353
Minicomputer-Based Systems 356
Desktop Computer-Based Systems 357

Automated Test Systems Instruments 328
Software 330
Controllers 331
Peripherals 335

Digitizers 336
Digital Storage Oscilloscopes 348

GPIB Programmable Instruments 358
Counter/Timers 360
Digital Multimeter 364
Function Generator 365
Power Supplies 366
Distortion Analyzer, Oscillator 367
Multifunction Interface, Function Cards 369
Scanner, Multiplexer 372

Modular Test & Measurement Instruments 373
Counter/Timers 374
Function Generators 378
Digital Multimeters 382
Pulse Generators 385
Power Supplies 388
Digital Latch 389
Oscillator 390
Distortion Analyzer 391
Current Amplifier, Probes 392
Amplifiers 393
Plug-In Oscilloscopes 394
Oscilloscope Calibration Generators 398
Mainframes 402
Accessories 404

Curve Tracers 407

Digital Photometer/Radiometer 417

Accessories 421
Cameras 422
Carts 431
Isolation Measurement Accessories 433
Probes 437
Probe Accessories 456
Adapting/Connecting Accessories 458
Mounting Accessories 460
Viewing Accessories 461

REFERENCE INFORMATION

Modular and Integrated Oscilloscopes 227

Understanding Oscilloscopes Specifications 228

Choosing a CRT Phosphor 230

Sampling Oscilloscopes 231

Storage Oscilloscopes 232

Digital Storage Oscilloscopes 234

Waveform Digitzers 235

Programmable General Purpose Instruments 235

Automated Test System 328

Signal Processing System Automation 353

Choosing a Scope Camera 422

Making Floating Scope Measurements 433

The Tektronix Instruments Group designs, manufactures, markets, supports, and services test and measurement products worldwide. The Instruments Group's products are test and measurement instruments and systems for scientists, engineers, and technicians in basic research, product design, manufacturing test, training, maintenance, and service applications in a broad range of industries and public institutions.

Products include:
— Fully-automated desktop-, computer- and minicomputer-based signal processing systems.
— The state-of-the-art laboratory 7000 Series plug-in instruments.
— The 5000 Series instruments, that continue the 7000 Series concept of flexibility and expandability with a line of plug-ins and mainframes for the cost-conscious user.
— A complete line of portable oscilloscopes that range from hand-held, battery-operated miniscopes to full-featured, high-performance instruments that have become the standards against which all other portables are measured.
— Two modular and compact product lines of general purpose instrumentation, including the cost-effective TM 500s and the GPIB-compatible and programmable TM 5000s.
— Curve tracers that acquire complete information about a multitude of semiconductor devices and integrated circuits and present it in a quickly comprehended curve.
— A portable digital photometer/radiometer with eight interchangeable probes for measuring illuminance, irradiance, luminance, LED output, and relative intensity.
— Accessories, from cameras to isolation measurement devices, that support all Instruments Division products.

MODULAR AND INTEGRATED INSTRUMENTS

There are two basic configurations for test and measurement instruments: modular and integrated. Modular instruments, also called "plug-in" or "laboratory" models, combine a mainframe and one or more interchangeable plug-in subassemblies. Integrated instruments (also called "monolithic") are one-piece units.

Although portable instruments are traditionally designed as integrated units, not all integrated instruments are portable, and some modular systems (such as scopes within the Tektronix TM 500 Instrument line) are designed for easy transport.

Modular Design Advantages
Examples of modular design in Tektronix Instrument Division products include the 7000 Series, the 5000 Series, the TM 500 General Purpose Plug-ins and the TM 5000 programmable units.

Versatility is the prime advantage of a modular instrument. Many more functions than could be economically or practically combined in a single unit are available by choosing the right plug-ins. Plug-ins can also extend the original instrument's range of functions. Digital multimeters, curve tracers, spectrum analyzers, and logic analyzers are just a few examples of the many specialized plug-ins Tektronix offers for modular oscilloscope mainframes.

Performance is another advantage. In the case of the 7000 Series instrument, modularity gives you the maximum performance available in an oscilloscope. And modularity also allows you to upgrade your instruments to take advantage of advances in technology.

Often modular instruments can be very cost effective too, because within a given product line, they can be shared. For example the TM 500 test and calibration plug-ins used in the lab for design work can be inserted in a portable mainframe and easily carried to the site of a service problem. Or as another example, a few high-performance laboratory plug-ins from the 7000 Series can be shared among several 7000 Series mainframes.

Consider the versatility and performance advantages as you read about the wide range of Tektronix modular instruments: page 236 for the 7000 Series instruments, page 284 for 5000 Series instruments, page 358 for TM 5000 Programmable Instruments, and page 373 for TM 500 Test and Measurement Instruments.

Integrated Design Advantages
Integrated instruments are often optimized for a single range of functions. One-piece instrument design can provide reductions in weight, increased ease of use, smaller size, lower power requirements, and often, higher performance/price ratios for your key requirements.

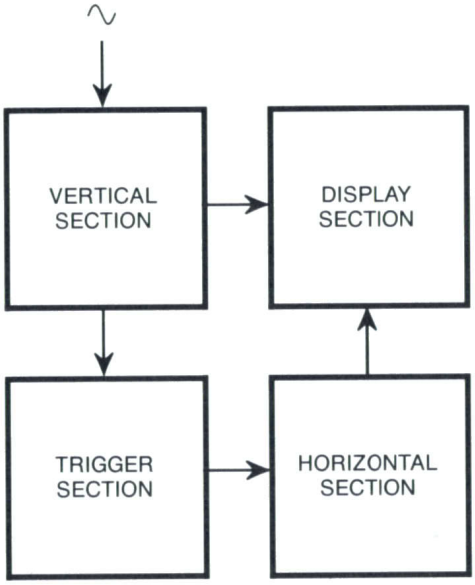
Portability can be essential for some test and measurement applications, and in these cases, an integrated design is often the best choice. Because a wide variety of options and optional accessories extend their ranges of applications, versatility can also be a feature of Tektronix integrated instruments.

Tektronix integrated scopes, either portable or rackmounted, are instruments where the design emphasis is often on the factors of economy, ruggedness, environmental protection, and internal or external battery power. See page 298.

KEY OSCILLOSCOPE SPECIFICATIONS AND FEATURES

You should choose an oscilloscope by matching both performance and features to measurement applications. Don't choose by performance alone, because when features make measurements easier, the result is likely to be more accurate measurements. And if your applications involve repetitive measurements, features that make the measurement faster will be cost-effective.

The key oscilloscope specifications and features described below may help you make a decision.



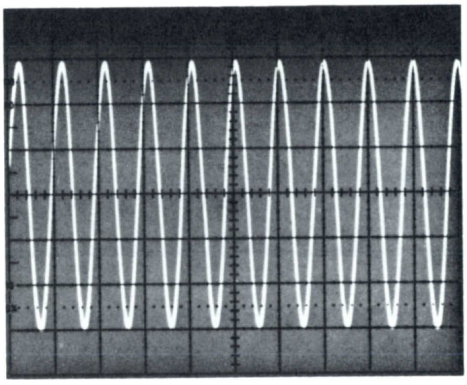
Vertical System Considerations

Because a faithful reproduction of the signal is necessary for measurement accuracy, and because very small signals must often be measured, the key specifications of the vertical system include bandwidth and sensitivity.

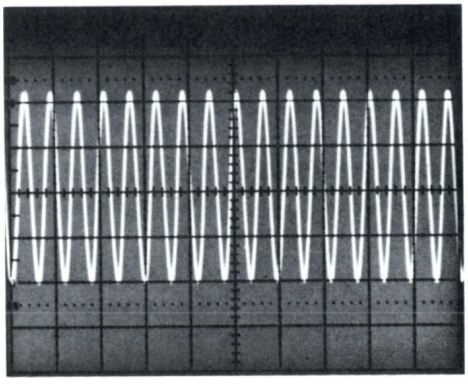
Depending on your applications, you might also want to consider oscilloscopes that display more than one signal at a time and those with differential or balanced inputs; these features are also described below.

Bandwidth and Risetime

Bandwidth is the range of frequencies that a scope can handle with less than a 3 dB loss in amplitude compared to midband performance. Since modern oscilloscopes work well at low frequencies down to dc, the bandwidth specification is commonly the highest frequency that can be displayed; dc as the lowest, is implied. The following figures illustrate bandwidth specifications.



OdB: 6 div at 50 kHz



–3 dB: 4.2 div at 100 MHz

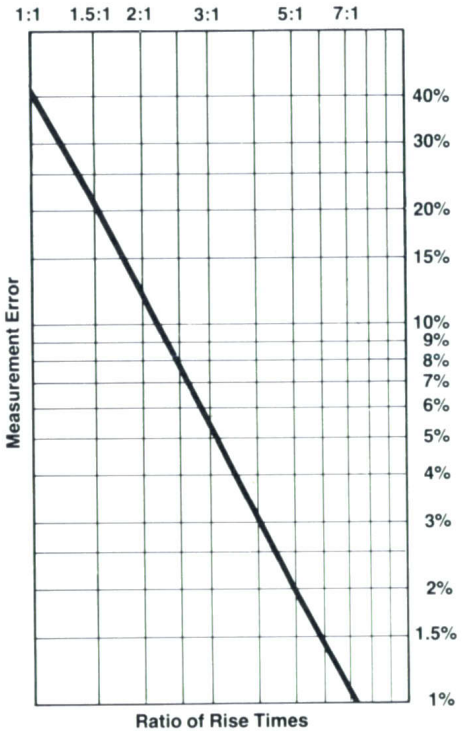
While a bandwidth specification is essential for the vertical system(s) of a scope, bandwidth is also sometimes specified for the horizontal system (which gives you a chance to evaluate performance in X-Y measurement applications) and for trigger systems (which permits you to determine the range of possible triggering signals).

Although bandwidth is the most important spec when making amplitude measurements, risetime is the specification to use if you are making timing measurements.

The frequency response of most scopes is designed so that there is a constant that allows you to relate the bandwidth and risetime of the instrument with this approximation:

$$T_r = \frac{0.35}{BW}$$

Given either specification (bandwidth or risetime), you can derive the other and determine if the instrument is suitable for your applications. The rule of thumb for timing measurements is to use an instrument with a risetime at least five times faster than the measurement you expect to make. A 5:1 ratio gives you a risetime measurement with ≤2% error. Other ratios and measurment errors are shown in the chart below.



Note that very accurate absolute-risetime measurements are not always a requirement. When you are comparing risetimes, for instance, an instrument risetime equal to those being measured is often adequate.

Sensitivity
An oscilloscope sensitivity specification describes the input signal level needed to produce a stated deflection of the electron beam within the CRT. Specifications typically are given in mV/cm or mV/div; with this spec you can determine if small signals will be displayed with enough amplitude for you to make measurements quickly and accurately.

Note that at a given state-of-the-art, sensitivity and bandwidth are trade-offs. The small amount of noise in even the best input circuit will mask very small signals. Raising the bandwidth also increases the noise picked up by the amplifiers, requiring a larger signal to create a clear display. As a consequence of this relationship, many high-sensitivity scopes provide bandwidth-limiting controls to allow you to make cleaner low-level measurements at moderate frequencies.

Although sensitivity specifications are most often associated with oscilloscope vertical channels, this specification can also be provided for horizontal systems and for trigger circuits.

Multiple Inputs
It is often quite useful to be able to view more than one input signal without disturbing the connections to your scope. Common applications include: comparisons of a device's input and output signals; checking signals against standards; making timing and/or phase measurements between events. These measurement requirements are usually satisified by dual-trace oscilloscopes that use electronic switching to alternately connect two input signals to a single deflection system. Dual-trace scopes offer the lowest cost and the best comparison capabilities (because there is a single horizontal amplifier and one set of deflection plates). On the other hand, since a fast transient event might occur on one channel while the beam is tracing the other, dual-beam scopes like the Tektronix 7844 (page 254) and 5113 (page 291) are recommended for viewing one-shot phenomena. The 5113 has two independent vertical systems and a common horizontal system and can display up to eight waveforms in its chop vertical operating mode. The dual-beam 7844 can be equipped with dual-time base plug-ins and then used to see a single event at different locations in the signal path, at two sweep rates if necessary.

Vertical System Operating Modes
Multiple inputs, the Add vertical operating mode, and the ability to invert one channel lets you cancel or reject any signal components equal in amplitude and phase that appears at both inputs. This ability provides a simple and accurate way to measure the difference between two signals, and of rejecting most unwanted signal components common to both inputs (such as power supply hum).

Other vertical operating modes are Alternate (in which a complete waveform from a vertical channel is drawn before switching to draw the other), Chopped (in which the scope draws small parts of the waveforms while switching back and forth between the channels at a fixed rate), and Trigger View.

The Trigger View mode is useful anytime you measure events dependent on an external triggering event. This capability is particularly useful in scopes such as the 468, where a zero-delay trigger view circuit is provided.

Horizontal System Considerations
The horizontal system of a modern oscilloscope provides a built-in sawtooth sweep generator. With this constant-speed horizontal deflection, measurements calibrated directly in units of time are possible. (As a consequence, the horizontal system of a scope is often called the time base.) This permits direct measurement of time between events, accurate time measurements on small portions of pulse trains, and even time measurements on single, nonrecurrent events.

Sweep Speeds
How fast a sweep speed do you need? One rule states that for frequency measurements at moderate frequencies, a sweep capable of displaying one cycle across the full horizontal scale is usually considered adequate. For example, one cycle of a 10 MHz signal can be displayed across 10 div with a 10 ns/div sweep. Don't apply this rule at ultrahigh frequencies, however, as scopes seldom have sweeps that fast.

Another approach emphasizes risetime measurements. For maximum accuracy here, the scope should show the step signal (squarewave, pulse, etc.) across most of the full vertical scale with the rising portion of the signal at nearly a 45° slope. For very fast risetimes, this objective is rarely met because of compounding difficulties and the cost of providing extremely fast sweeps which are both linear and accurate.

Though neither rule can be applied at the very limits, fast sweep speeds are readily available: sweeps to 5 ns (500 ps/div magnified) in the portable 2465; to 200 ps/div with plug-in time bases for laboratory scopes; or to 10 ps/div with sampling plug-ins. (See Sampling Applications on page 231.)

Delayed Sweep Measurements
Delayed sweep scopes can offer you many measurement advantages. If the scope has two calibrated time bases and the alternate horizontal operating mode (electronic switching of the trace between time bases), then convenient comparisons of the same signal at two different sweep speeds are possible.

If the second time base has an independent trigger, then jitter-free measurements on the delayed sweep are possible.

In every case, timing measurements with delayed sweep are easier to make, and in most cases, there is increased timing measurement accuracy. Many plug-in time bases for laboratory scopes and most portable scopes offer delayed sweep.

Accuracy
Accuracy in a scope's horizontal system is as important to timing measurements as vertical accuracy is to amplitude measurements. Horizontal accuracy to 1.5% is possible with several 7000 Series plug-in time bases and to 1% with the 2445 and 2465 Portable oscilloscopes.

Trigger System Considerations
Besides sensitivity and bandwidth, the flexibility of a trigger system should be a consideration when choosing a scope. Some trigger system features you might need for your measurement applications include:

High and low frequency reject coupling — for stable triggering with noisy signals.
TV triggering — for automatic synchronization with video signals.
Alternate triggering — for steady display of either signal with dual-channel scopes.
Peak-to-peak auto triggering — for quick, convenient triggering with automatic level limits.
Variable trigger holdoff — permits trigger holdoff period to be varied to trigger on repetitive complex waveforms.
Single sweep operation — for special applications such as capturing a transient pulse and for CRT photography.

CRT System Considerations
CRT system specifications will tell you how well the scope can display waveforms for direct viewing and for photography. A full complement of CRT system controls contributes greatly to the instrument's ease of use.

CRT Controls
CRT system controls to consider include:
Beam Finder — A single pushbutton that allows you to quickly locate any off-screen trace.
Auto Focus — Auto focusing on both laboratory and portable scopes reduces the need for manual readjustments with changes in trace intensity; very useful when traces are displayed at different sweep rates as in alternate time base operations.
Auto Intensity — Reduces trace intensity adjustments over a wide sweep-speed range.
External Z-Axis Input — Permits trace brightness modulation, makes some measurements easier by identifying events with an intensified zone on the trace.

PHOTOGRAPHIC WRITING RATE

Photographic writing rate is a measure of the scope/camera/film's capability to record high speed signals.

Recording high speed signals on film is dependent on at least three factors, the oscilloscope used, film charcteristics, and the camera. For maximum writing rate capability, the objective is to get as much light energy to the film surface as possible. Since each component affects photographic writing rate, the selection for top performance is important.

The fastest writing rate oscilloscope available is the 7104. At 20 cm/ns, the 7104 utilizes a unique microchannel plate CRT with GH (P31) phosphor standard. The chart shown graphs the response of the 7104 along with other 7000 Series mainframes. (The other mainframes shown in the graph utilize optional BE (P11) phosphor to achieve the writing rate performance indicated.)

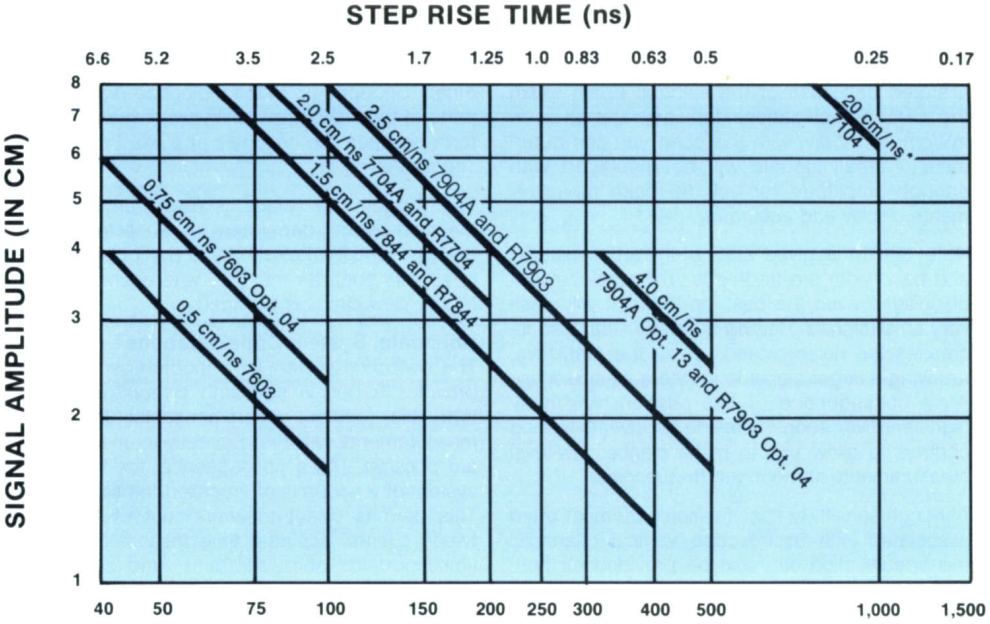
Tektronix manufactures a variety of cameras designed for use with oscilloscopes. Two key parameters are the f-number of the lens and the magnification. These parameters affect the light gathering capability of the camera. The chart utilizes a f/1.2 Tektronix C-51 Camera. More information on cameras is available on page 422.

Film characteristics are also an important parameter. Generally, the higher the ASA rating of the film used, the higher the film sensitivity and thus, photographic writing rate. It should be recognized that film speed can vary with storage conditions and environmental factors. More information is available from film vendors.

Writing Rate Comparison Graph

On the graph, vertical signal amplitude on the vertical scale is shown against maximum sinewave frequence (lower scale) and fastest risetime (upper scale). These speeds assume a small horizontal spot velocity compared to the maximum vertical velocity. The ramp is assumed to be a linear ramp measured between the 10% and 90% points.

There is an application note available from Tektronix which further describes photographic writing rate, including measurement procedures and applications. It is available on request by referencing 42W-5335.



Amplitude vs speed and photographic writing speed comparison of 7000 Series mainframes using BE (P11) Phosphors (Option 78). 20,000 ASA film and the C-51 (f/1.2, 1:0.5) Camera.

BE (P11) Phosphor has a different spectral output than GH (P31) and more closely matches the sensitivity spectrum of silver halide film types. While photographic writing speed is approximately two times the GH (P31) rate, the visual output luminance is approximately 15% of GH (P31) standard. Using Polaroid Film Type 107, 3,000 ASA w/out film fogging.

**20 cm/ns is the specified photographic writing speed for the 7104 Mainframe. However, it is not directly comparable to the other mainframes here because of relaxed phosphor, film and camera requirements. The microchannel plate CRT as well as the bright photographed image allow for these relaxed requirements. Standard (GH) P31 Phosphor is used and a C-53 (f/1.9, 1:0.85 image) Camera, using Polaroid Type 107, 3,000 ASA without film fogging.*

Writing Speed Enhancers

A writing speed enhancer provides controlled fogging of the film to increase its sensitivity. The degree of writing speed improvement is variable, and is dependent on the film, camera, and scope combination used. More information is available on page 423.

Selecting a Phosphor

The catalog description of each oscilloscope indicates the phosphors normally supplied or available as options. While a special phosphor may be desirable for a specific measurement application, remember that each phosphor has its own color, persistence, burn resistance, etc. Improvements in one characteristic are usually at the expense of others. The chart below provides comparisons.

COMPARATIVE CRT PHOSPHOR DATA

Phosphor*4			Phosphorescence Where Different from Fluorescence	Relative Luminance*1	Relative Photographic Writing Speed*2	Decay	Relative Burn Resistance	Comments	Ordering Information Option
WTDS	JEDC	Fluorescence							
GJ	P1	Yellowish-green	—	50%	20%	Medium	Medium	Replaced by P31 in most applications	Special order
WW	P4	White	—	50%	40%	Med-Short	Med-High	Television displays	74
GM	P7	Blue	Yellowish-green	35%	75%	Long	Medium	Long decay, double-layer screen	76
BE	P11	Blue	—	15%	100%	Med-Short	Medium	For photographic applications	78
GH	P31	Green	—	100%	50%	Med-Short	High	General purposes, brightest available phosphor	80
GR	P39	Yellowish-green	—	27%	NA*3	Long	Medium	Low refresh rate displays	40
GY	P43	Yellowish-green		40%	NA*3	Medium	Very High	High current density phosphor	Special order
GX	P44	Yellowish-green		68%	NA*3	Medium	High	Bistable storage	
WB	P45	White	—	32%	NA*3	Medium	Very High	Monochrome TV displays	

**1 Measured with Tektronix J16 Photometer and J6523 Luminance Probe which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. P31 as reference.*
**2 P11 as reference with Polaroid 612 or 106 film. Representative of 10 kV aluminized screens.*
**3 Not available.*
**4 Tektronix is adopting the Worldwide Phosphor Type Designation System (WTDS) as a replacement for the older JEDEC "P" number system referenced in this catalog. The chart lists the comparable new WTDS designations for the most common "P" numbers.*

DIGITAL ADDITIONS

You can make delay and time interval measurement with digital ease on several Tektronix oscilloscopes. The DM 44 factory-installed option for 464/466 Storage scopes allows you to read the delay time, time interval, or frequency right from an LED readout, with no calculation or interpolation required. The DM 44 also incorporates a digital volt/ohm meter and temperature-measurement capabilities.

The 7B10, 7B15, 7B85 and 7B80 plug-ins for the 7000 Series oscilloscopes also provide Δtime measurements. With these plug-ins the time interval measurement can be shown on the screen using the 7000 Series CRT readout capability.

For 7000 Series instruments, there is a wide variety of other digital plug-ins. These include a universal counter/timer, a digital multimeter with a temperature mode, digital delay by time or events, a versatile 0.01% A/D converter with vertical amplifier, and a special read-out unit to label each test for future reference.

The digital plug-ins offer many advantages over separate test units such as: increased accuracy, scope-controlled digital measurements, measuring convenience and confidence, easier and faster solutions to complex problems, a lower dollar investment, more bench space, and signal conditioning.

SAMPLING APPLICATIONS

Sampling is a powerful technique for examining very fast repetitive signals. In principle, sampling is similar to the use of stroboscopic light to study fast mechanical motion. Progressive samples of different portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low-bandwidth amplifiers, and finally shown (all seemingly at one time) on the screen of a CRT. The display produced is a replica of the sampled waveforms.

This sampling technique is limited to depicting repetitive signals, since no more than a portion of the signal is captured and displayed each time the signal occurs. The sampling method, however, provides a means of examining fast-changing signals of low amplitude that cannot be examined in any other way.

Sampling scopes are capable of resolving events that occur in less than 30 ps on an "equivalent" time base of less than 20 ps/div with less than 5 mV of peak amplitude.

If your measurement needs require equivalent bandwidths to 14 GHz or sweeps to 10 ps/div, consider the sampling plug-ins described on page 282.

To determine which instrument fits your requirements, refer to the sampling decision tree on page 277.

MODULAR NONSTORAGE OSCILLOSCOPES

Product	Bandwidth*1	Minimum Deflection Factor	Number of Traces	Maximum Sweep Rate	Delayed Sweep	Page	Price*2
7104	1 GHz	10 mV/div at BW	up to 4	200 ps/div	X	244	$21,380
7904A R7903	500 MHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	500 ps/div	X	246 246	$8,810 $8,515
7844	400 MHz	20 mV/div at BW 10 μV/div 1 mA/div	up to 4 Dual-Beam	1 ns/div	X	254	$13,435
7704A Opt 09	250 MHz	20 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	X	248	$5,020
7704A	200 MHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	X	248	$4,520
7603	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	5 ns/div	X	250	$2,865
5440	50 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	5 ns/div	X	287	$2,760
5110 5116	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	100 ns/div	X	291 292	$1,505 $2,335
7603N11S	Ruggedized oscilloscopes system [meets or exceeds MIL-0-24311 (EC) (AN/USM 281 Specs)]	5 mV/div at BW	up to 2	5 ns/div	X	252	$8,040

*1 *Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.*
*2 *Price does not include plug-ins.*

PORTABLE NONSTORAGE OSCILLOSCOPES

Product	Bandwidth	Minimum Deflection Factor	Dual-Trace	Maximum Sweep Rate	Delayed Sweep	Page	Price
485	350 MHz	5 mV/div at BW	X	1 ns/div	X	312	$8,320
465M	100 MHz	5 mV/div at BW	X	5 ns/div	X	312	$4,010
2465						303	$4,750
2445						303	$3,250
2337	100 MHz	5 mV/div at BW	X	5 ns/div	X	306	$3,395
2336	100 MHz	5 mV/div at BW	X	5 ns/div	X	306	$2,995
2335	100 MHz	5 mV/div at BW	X	5 ns/div	X	308	$2,795
2235						308	$1,650
2236						308	$2,650
2215	60 MHz	2 mV/div at BW	X	5 ns/div	X	310	$1,450
2213	60 MHz	2 mV/div at BW	X	5 ns/div	X	310	$1,200
335	35 MHz	10 mV/div at BW 1 mV/div	X	20 ns/div	X	314	$3,135
305	5 MHz	5 mV/div at BW	X	100 ns/div	X	305	$2,405
221	5 MHz	5 mV/div at BW	X	100 ns/div	X	316	$1,910
213	1 MHz	20 mV/div at BW 5 mV/div		400 ns/div	X	317	$2,510
212	500 kHz	10 mV/div at BW 1 mV/div	X	1 μs/div	X	318	$1,775
SC 504*1	80 MHz	5 mV/div at BW	X	5 ns/div		395	$3,200
SC 502*1	15 MHz	5 mV/div at BW 1 mV/div	X	20 ns/div		397	$2,340

*1 *The SC 502 and SC 504 are oscilloscopes that must be plugged into a TM 500/TM 5000 Mainframe for operation.*

STORAGE

When a conventional oscilloscope cannot capture an event and display it for your measurements because the signal is too slow, or too fast and infrequent, or when you need to compare events that happen at different times instead of simultaneously, consider a storage scope. These are obvious applications, but there are many other situations that also call for the unique advantages of storage including:

Observing signal changes during circuit adjustments
Comparing new signals with a standard
Increasing the brightness of a dim, low-repetition-rate signal for normal viewing
Reducing flicker or noise in a signal
Babysitting (unattended monitoring) for a transient event
Capturing fast signals that occur infrequently or only once
Capturing a complete display of a slowly occurring signal
Enhancing other record-keeping techniques like photography

With the right Tektronix storage instrument, the capabilities you need are available, and the storage time can be anywhere from a few minutes to a practically unlimited length of time depending on your choice of instruments.

Types of Storage Oscilloscopes

Two broad categories of storage instruments are named for the storage medium. CRT storage scopes store the captured waveform when the electron beam writes on a target within the cathode-ray tube. Digital storage scopes quantize the waveform and then store it in a digital memory. In addition there are waveform digitizers; a very special class of storage instruments available in the Tektronix 7000 Series. Within each category there are different technologies and each has its own set of features and benefits.

Bistable CRT Storage

The phosphor in a bistable CRT storage scope has two stable states: written and unwritten. Once stored, this phosphor allows waveforms to be displayed typically for several hours, or until it is erased by the operator. Bistable storage is the easiest CRT storage type to use. It is also the least expensive CRT storage technology. It features bright, long-lasting displays, but in comparison with other storage technologies, bistable storage displays have less contrast.

The advantages of bistable storage make it particularly useful for mechanical measurements, signal comparisons, and data recording.

Split-screen viewing is another advantage of most bistable storage scopes. The feature allows a reference waveform to be stored on one half the screen while the other half can be used to store the effects of changes made on the circuit. You can also use the split screen to have the reference waveform in the stored mode and the other half of the display in the nonstored mode to monitor an external input.

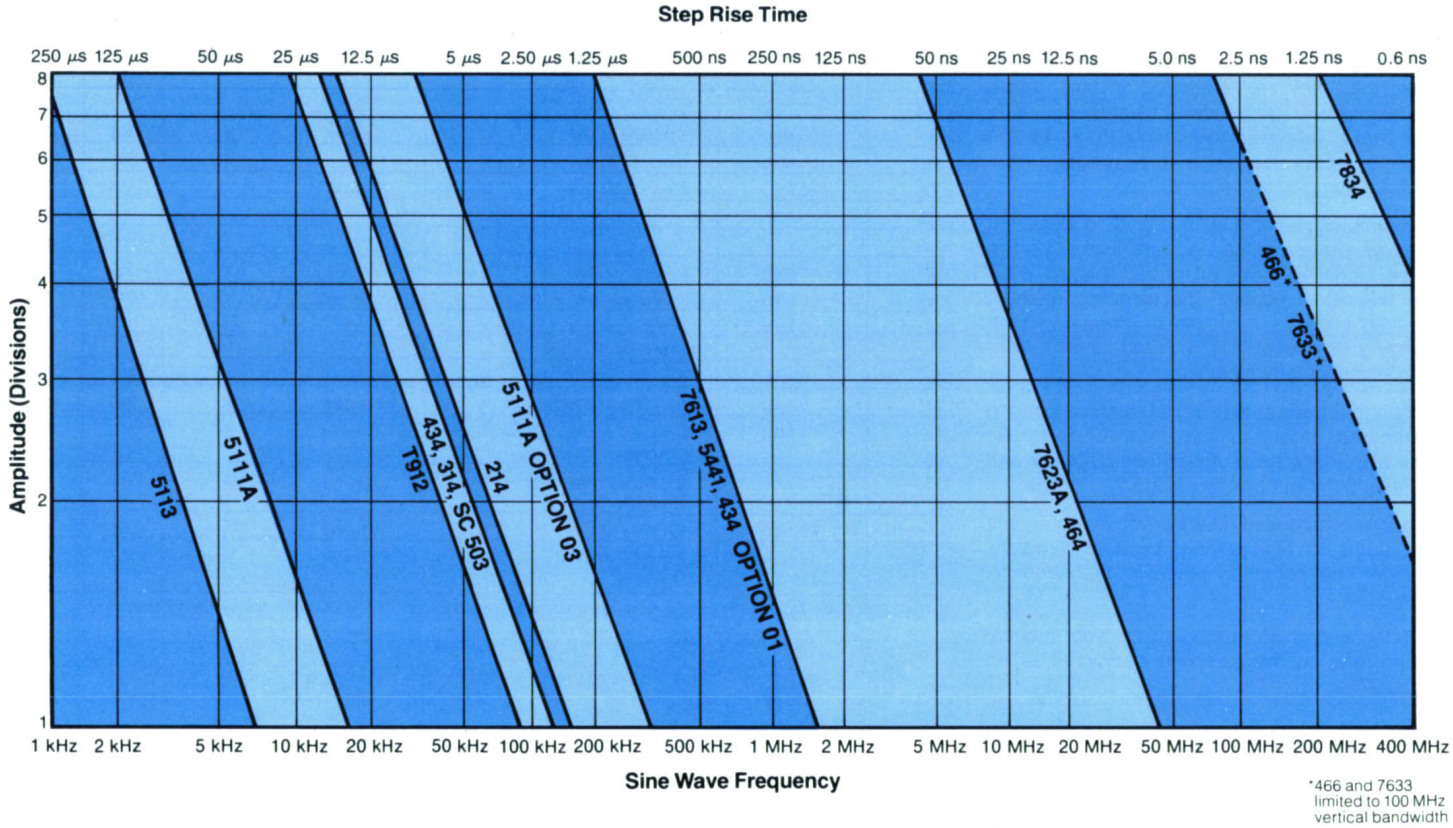
Variable Persistence CRT Storage

If you don't need to store waveforms for hours at a time, variable-persistence CRT storage has advantages. The variable-persistence storage CRT has a storage mesh where the electron beam writes the input signal; thereafter, flood guns in the CRT illuminate the phosphor where the storage mesh permits.

CRT storage controls vary the charge on the mesh, allowing you to control the contrast between the trace and the background and to fine tune how long the trace is stored.

The first capability provides easy viewing with high constrast between the dark background and bright waveforms. And this type of storage provides the best displays when viewing traces with varying intensities (such as delaying and delayed sweeps, or traces with external Z-axis intensity modulation).

CRT STORAGE PERFORMANCE



*466 and 7633 limited to 100 MHz vertical bandwidth

Varying the persistence permits you to set up the scope so that the entire waveform can be viewed, yet the stored trace will fade from view just as a new waveform is being stored. Or you can view several traces before the first one fades from view. Then you can see signal response variations as you make changes in a circuit.

Variable persistence can also be used to provide display integration so that only the coincident portions of a repetitive signal are displayed. Aberration or jitter not common to all traces will not be stored or displayed. Low repetition rate, fast risetime signals that are not discernible on conventional CRT's can be easily viewed with this storage technology by allowing each repetition to build up the trace brightness.

Applications for variable persistence storage include spectrum analysis, time-domain reflectrometry, sampling, and any other measurements that require displays of low-repetition-rate signals.

Fast Transfer CRT Storage

Fast transfer storage scopes use a CRT with a special intermediate mesh target optimized for speed. This target captures the waveform and then transfers it to another mesh, one optimized for longer-term storage. As the name implies, the fast transfer storage mode provides increased writing speed (see the next heading) for the 466 portable oscilloscope and the 7623A, 7633, and 7834 lab scopes.

The second target can also be designed to offer bistable, variable persistence or both modes in combination with the transfer mesh or by itself. In the 7623A, 7633, and 7834, this combination of capabilities provides unique multi-mode storage instruments. Using front panel controls, you can select the operating mode suited to your specific measurement situation.

Stored Writing Speed

For CRT storage scopes, the storage capability specification is the stored writing speed. This figure of merit is expressed in distance per unit of time. Often div/μs is more meaningful in terms of your measurements. But because some scopes have nonstandard sized graticules (i.e., other than 1 cm square major divisions) cm/μs is useful for comparisons.

The specification is dependent on the speed and amplitude of the input signal. If you know the pulse risetime or sinewave frequency of the input signal and the amplitude of the waveform you want to display, you can use the chart on page 232 to determine which storage scope is recommended.

CRT STORAGE OSCILLOSCOPES

(In Order of Stored Writing Speed)

Product	Stored Writing Speed	View Time	Type of Storage	Bandwidth*1	Minimum Deflection Factor	Number of Traces	Delayed Sweep	Plug-in	Page	Price
7834	5500 div/μs 776 div/μs 12 div/μs 0.2 div/μs	30 s*3 30 min*4 minimum 30 s*3 30 min*4 minimum	Fast variable persistence Fast bistable Variable persistence Bistable	400 MHz	20 mV/div at BW; 10 mV/div at 325 MHz	Up to 4	X	X	256	$12,415
466	3000 div/μs 3 div/μs	15 s*3 15 s*3	Fast variable persistence Variable persistence	100 MHz	5mV/div at BW	Up to 2	X		321	$7,090
7633	2200 div/μs 400 div/μs 3 div/μs 0.2 div/μs	30 s*3 30 min 30 s*3 30 min minimum	Fast variable persistence Fast bistable minimum Variable persistence Bistable	100 MHz	5 mV/div at BW; 10 μV/div; 1 mA/div	Up to 4	X	X	258	$8,235
7623A	150 div/μs 50 div/μs 0.5 div/μs 0.03 div/μs	30 s*3 30 min minimum 30 s*3 30 min minimum	Fast variable persistence Fast bistable Variable persistence Bistable	100 MHz	5 mV/div at BW; 10 μV/div; 1 mA/div	Up to 4	X	X	259	$6,310
464	110 div/μs 0.5 div/μs	15 s*3 15 s*3	Fast variable persistence	100 MHz	5 mV/div at BW	Up to 2	X		321	$5,695
7613	5 div/μs	1 hr	Variable persistence	100 MHz	5 mV/div at BW; 10 μV/div; 1 mA/div	Up to 4	X	X	260	$5,330
5441	5 div/μs	1 hr	Variable persistence	50 MHz	5 mV/div at BW; 10 μV/div; 0.5 mA/div	Up to 8	X	X	288	$4,675
434 Opt 01 434	5 div/μs 0.4 div/μs	4 hrs	Bistable split screen	25 MHz	10 mV/div at BW; 1 mV/div	Up to 2			323	$5,550 $5,150
5111A Opt 03 5111A	0.8 div/μs 0.05 div/μs	10 hrs	Bistable split screen	2 MHz	1 mV/div at BW; 10 μV/div; 0.5 mA/div	Up to 8	X	X	290	$2,580 $2,430
214	0.5 div/μs	1 hr	Bistable	500 kHz	10 mV/div at BW; 1 mV/div	Up to 2			325	$2,410
314	0.4 div/μs	4 hrs	Bistable	10 MHz	2 mV/div at BW	Up to 2			324	$3,800
T912	0.25 div/μs	4 hrs	Bistable	10 MHz	2 mV/div at BW	Up to 2			326	$2,255
SC 503*2	0.08 div/μs	4 hrs	Bistable	10 MHz	1 mV/div at BW	Up to 2			396	$3,440
5113	0.02 div/μs	10 hrs	Bistable split screen	2 MHz	1 mV/div at BW; 10 μV/div; 0.5 mA/div	Up to 8 dual-beam	X	X	291	$3,535

**1 Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.*

**2 The SC 503 is an oscilloscope that must be plugged into a TM 500/TM 5000 Mainframe for operation. Please turn to page 340 for more information.*

**3 View times are at full stored display intensity. They may be increased by using reduced intensity in the save display mode.*

**4 Save intensity at minimum.*

Digital Storage

The fundamental difference between digital storage scopes and CRT storage scopes is that digital scopes quantize the captured waveform and CRT storage scopes do not. Having quantized waveforms in a digital memory gives you measurement capabilities not possible with any other kind of oscilloscope.

With digital storage scopes, you have the advantage of pretrigger viewing. In other words you can look at a waveform both before and after the trigger event. Another feature is "baby-sitting"; available because the digital storage scope's trigger can stop, as well as start signal acquisition.

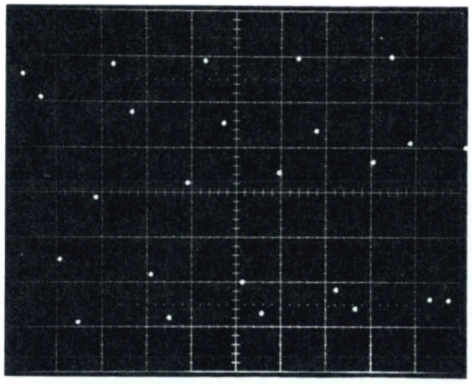
Other digital storage scope advantages include signal processing features like averaging a number of samples of the input signal to reduce the effects of noise; performing calculations on the waveform parameters; or outputting the signal data over RS-232 or GPIB standard interfaces.

Digital storage scopes are typically easy to use and give you crisp, clear displays. Because the data is stored in a digital memory, no fading or blooming of the trace on the CRT phosphor will occur, and storage time is essentially unlimited. This type of storage is excellent for many applications involving single-shot or low-repetition signals, or where the unique advantages of a digitized waveform may be the answer to your measurement needs.

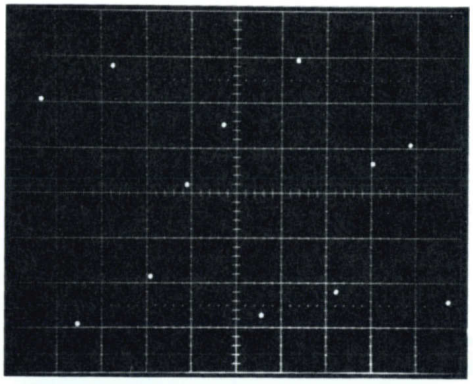
Quantization Techniques

Within digital storage scopes there are two main techniques of quantizing signals — and the technique has a direct effect on the applications of the instruments in that only one kind of digital storage scope can capture single-shot signals.

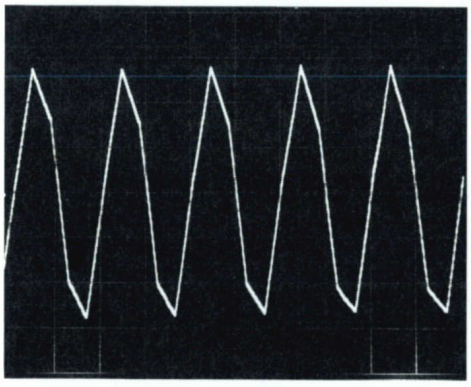
The digital scopes that can capture signals in a single sweep use what is called "real-time sampling". Other digital storage scopes use "equivalent-time sampling". There are two equivalent-time sampling methods and both require many repetitions of the input signal. In exchange for that requirement you have the ability to measure signals more than ten times faster than can be captured with real-time sampling.



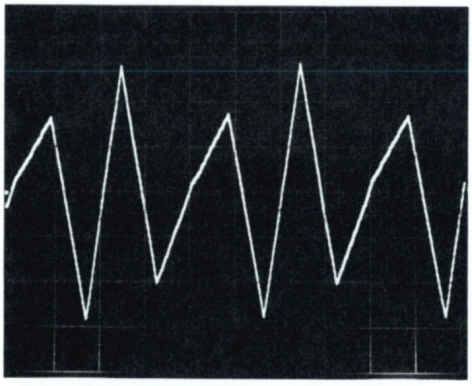
With Dot Display 5 MHz Signal



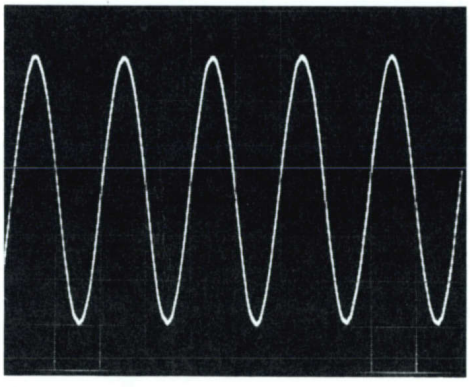
10 MHz Signal



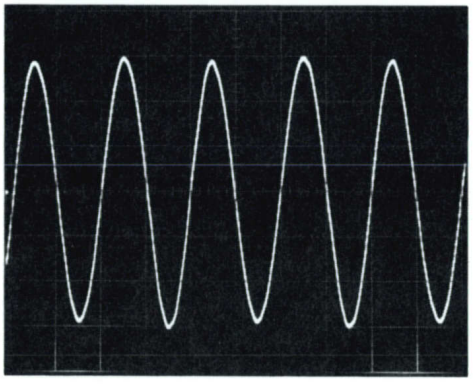
With Pulse Interpolator 5 MHz Signal



10 MHz Signal



With Sine Interpolator 5 MHz Signal



10 MHz Signal

Digitizing Rate — 25 MHz

Digital Storage Scope Specifications

For digital storage oscilloscopes that use real time sampling, there is a useful storage bandwidth specification. It expresses the highest frequency sinewave that can be captured in a single sweep and displayed so that you can make measurements. Both the digitizing rate (how often the scope takes samples) and the display reconstruction technique (how the scope displays what's in its memory) must be taken into account in the useful storage bandwidth. See the examples below.

For Digital scopes using equivalent time sampling, the specificaton is "equivalent-time bandwidth", the highest frequency signal that can be stored and displayed with less than 3 dB signal amplitude loss. Besides analog specifications (common to all oscilloscopes), other specifications of interest to digital scope users are:

Maximum Digitizing Rate — How often the instrument takes samples of the input signal.

Vertical Resolution (usually expressed in "bits of resolution) — How finely the instrument can discriminate between signals very much alike in voltage; for example, 8 bits of resolution is 0.391% when expressed as a percentage, and 10 bits is 0.098%.

Data Word Per Waveform or Horizontal Resolution — How many words of digital memory are used to store the captured waveform; if the signal is stored in 512 data words, the horizontal resolution is 1 in 512 or 0.195%.

NEW Color Digital Storage Oscilloscope

Tektronix has developed an entirely new method of producing color displays, and combined this with digital storage in our 5116 Oscilloscope. This liquid crystal display technology is described in the color reference section beginning on page 9. Full product specifications are on page 292.

Your local Tektronix Sales Engineer, Representative, or Distributor can help you determine the digital oscilloscope parameters necessary to meet your measurement applications needs.

The Tektronix digital storage scopes are:

336	Portable Digital Storage Oscilloscope. Useful storage bandwidth of 140 kHz, microprocessor controlled with features and modes chosen from menu on CRT.
468	Portable Storage Oscilloscope. Real-time sampling to 10 MHz and special features like the envelope operating mode, a very useful glitch-catching feature.
5D10	Waveform Digitizing Plug-in for the 5000 Series offering real time sampling to 100 kHz, CRT readout, 8-bit vertical resolution, and up to 1024 data words/waveform.
5223	Digitizing Oscilloscope with 10 bits of vertical resolution, roll mode, X-Y plotter output, and optional GPIB interface.
7D20	Waveform-Digitizing Plug-in with dual samplers (capable of capturing two independent 25-ns-wide transient events) and with displays of six independent signals as well as a reference waveform.
7854	Waveform Processing Oscilloscope with 400 MHz equivalent-time bandwidth, keystroke programming, and calibrated sweep speeds to 500 ps/div.

DIGITAL OSCILLOSCOPES AND WAVEFORM DIGITIZERS

	390AD Programmable Digitizer	468 Digital Storage Oscilloscope	5223 Digital Storage Oscilloscope	7854 Waveform Processing Oscilloscope	7912AD Programmable Digitizer	7612D Waveform Digitizer	5D10 Programmable Digitizer	7D20/7D20T Storage Digitizers	336 Digital Oscilloscope
Page	**342**	**350**	**348**	**340**	**346**	**344**	**293**	**337**	**352**
Digitizing Technique	Dual stage flash conversion	Flash conversion	Successive approximation	Successive approximation	Scan conversion	EBS*1 flash converter	Successive approximation	CCD/successive approximation	Successive approximation
Maximum Sample Rate (Single Shot)	60 MS/s (16.6 ns/point)	25 MS/s (40 ns/point)	1 MS/s (1 μs/point)	500 kS/s (2 μs/point) using 7B87 ext. clock	100 GS/s (10 ps/point)	200 MS/s (5 ns/point)	1 MS/s (1 μs/point)	40 MS/s (25 ns/point)	1 MS/s (1 μs/point)
Vertical Amplifier Analog Bandwidth	15 MHz	100 MHz	10 MHz	400 MHz (14 GHz w/7S12)	500 MHz w/7A29 (200 MHz w/7A16P)	80 MHz	100 kHz	70 MHz	50 MHz
Vertical Resolution	10 bits	8 bits	10 bits	10 bits	9 bits	8 bits	8 bits	8 bits	8 bits
Record Length	2048 to 4096 points	256 to 512 points	204 to 1016 points	128 to 1024 points	512 points	256 to 2048 points	256 to 1024 points	1024 points	1024 points
Input Channels	2	2	Up to 4	Up to 4	1	2	2	2	2
Simultaneous Channel Acquisition	Yes	Chopped	Yes: 2 Chopped: 4	Chopped: 2	N/A	Yes	Yes	Yes	Yes
Independent Time Bases	1 + delaying	1 + delaying	1	1	1	2	1	1	1 + delaying
Maximum Sweep Speed	(16.6 ns/point)	2 ns/div	200 ns/div	500 ps/div (20 ps/div w/7S12)	500 ps/div	(5 ns/point)	100 μs/div	50 ns/div	10 ns/div
Pretrigger	Yes	Yes	Yes with 5B25N	Yes with 7B87	No delay line	Yes	Yes	Yes*2	Yes
Minimum Ext Clock Interval	16.6 ns/point	N/A	1 μs/point	2 μs/point	N/A	5 ns/point	1 μs/point	100 μs/point	N/A
Waveform Storage Registers	2	2 to 4	2 to 4	2 to 16 (5 to 40 with Option 2D)	1	2 to 16	1 to 6	6	2 (18 with Option 01)
Waveform Processing	Cursors	Cursors, averaging, enveloping	—	Cursors, averaging, parameters, keystroke programming	—	—	Cursors	Cursors, averaging, enveloping	Cursors, averaging, enveloping, CH 1 X CH 2, RMS, mean
Waveform Data Output	Binary	Binary	ASCII or binary (Option 10)	ASCII	Binary	Binary	None	ASCII or binary	Binary
Other	Sample rate switching, digital plotter output	Sine/pulse interpolator optional XY recorder output	Roll mode XY recorder output	Waveform calculator waveform processing systems available	Waveform processing system available	Sample rate switching, waveform processing systems available	XY recorder output	Roll mode nonvolatile front panel settings "scope-like" front panel	Roll mode, XY recorder output, CRT readout, 11 lbs.

**1 Electron Bombarded Silicon.*

**2 The 7D20/7D20T has pretrigger capability in the equivalent time digitizing range for repetitive waveforms as well as for single shot.*

WAVEFORM DIGITIZERS

Along with conventional oscilloscopes, plug-in or integrated, and with storage oscilloscopes, both digital and analog, Tektronix leads the way in waveform acquisition instruments. This commitment to the future of test and measurement instrumentation can be seen today in three programmable waveform digitizers.

The 390AD Programmable Waveform Digitizer is a dual-channel waveform-acquisition digitizer with a maximum sampling rate of 30 MHz (or 60 MHz in single channel operations). Vertical resolution is 10 bits and the memory length is 2048 data words (4096, single channel) with one breakpoint provided to allow changing the digitizing rate during waveform digitizing. More information is available on page 342.

The 7612D Programmable Waveform Digitizer has full dual-channel operations, a maximum sampling rate of 200 MHz, selectable record lengths from 256 to 2048 data words, and the ability to change sampling rates several times during waveform digitizing. See page 344.

The 7912AD Programmable Transient Waveform Digitizer captures waveforms with a scan converter CRT capable of recording 500 MHz single-shot signals. See page 346 for more information if your applications demand equivalent digitizing rates to 100 GHz and 9-bit resolution both vertically and horizontally.

TM 500 MANUAL INSTRUMENTS

The Tektronix TM 500 line is a modular system. One-, three-, four-, five-, and six-compartment mainframes accept a broad selection of plug-in instruments. The mainframe provides a common primary power supply, keeping total instrument weight, size, and cost down. Just as important, TM 500 mainframes also provide a signal control and data interface between modules. This allows TM 500 instruments to work either individually or together as integrated measuring systems. The Tektronix TM 500 Instrument line is extensive—more than 35 instruments, including digital multimeters, counter/timers, power supplies, signal sources, oscilloscopes, and more. Custom plug-in kits allow you to add your own unique circuits. With this feature, you can also apply TM 500's capability to unusual applications.

The TM 500 Instrument line has several configurations designed for portability. The TM 515 Traveler Mainframe easily fits under an airline seat when traveling but works like a lab bench setup. Although it is attractive and convenient enough to treat as carry-on luggage (it will even go beneath your seat on most airlines), the TM 515 is designed to take rugged travel. It carries up to five TM 500 plug-in instruments. The TM 503 three-compartment mainframe or the TM 504 four-compartment mainframe, with carrying case or protective cover, provide additional protability for the TM 500 instruments. Again, relatively lightweight, rugged construction, and convenient size are the key to portability.

TM 5000 PROGRAMMABLE INSTRUMENTS

The Tektronix TM 5000 products extend the TM 500 concept of configurability to a line of IEEE Standard 488 compatible, fully programmable measurement, stimulus, and interfacing instruments. Tek's TM 5000 programmables are the easiest IEEE Standard 488 test and measurement instruments you can use. Because they are compatible with our TM 500 line of modular instrument, it is possible to configure literally hundreds of customized systems—systems that are programmable, manual, or hybrid—with plug-in, pull-out ease.

Tek's ***Standard Codes and Formats*** make communication between TM 5000 instruments easier than ever before. This same set of ***Standard Codes and Formats*** is used to communicate with all the Tektronix IEEE Standard 488 instruments, such as the 7854 and 468 oscilloscopes, and the 492P Spectrum Analyzer. TM 5000 commands are mnemonic. Each bus command is in "standard engineering English", matching the front panel nomenclature—ideal for the programmer who realizes the frustrations of working with many of today's instruments.

With the Learn Mode, one keystroke transfers a complete front panel setup to the controller for storage in memory. This greatly increases the productivity of the engineer by reducing setup time where test settings are constantly changing. You can change a routine without having to reprogram the whole system.

All TM 5000 programmables have an internal diagnostics capability designed right in. They perform self-test on power-up, and indicate an error if a malfunction has occurred. Plus they've all been designed for fast troubleshooting using signature analysis. All are UL listed.

As with TM 500, TM 5000 programmable systems take up less than half the space of standard rackmount equipment. This size advantage really pays off—on the bench, on the manufacturing floor, or in the field where portability is essential.

7000 SERIES INSTRUMENTS

CONTENTS

Reference 237

7000 Series
Nonstorage Mainframes 243

7000 Series
CRT Storage Mainframes 255

7000 Series Plug-ins 262

The 7000 Series . . .

Superior Performance

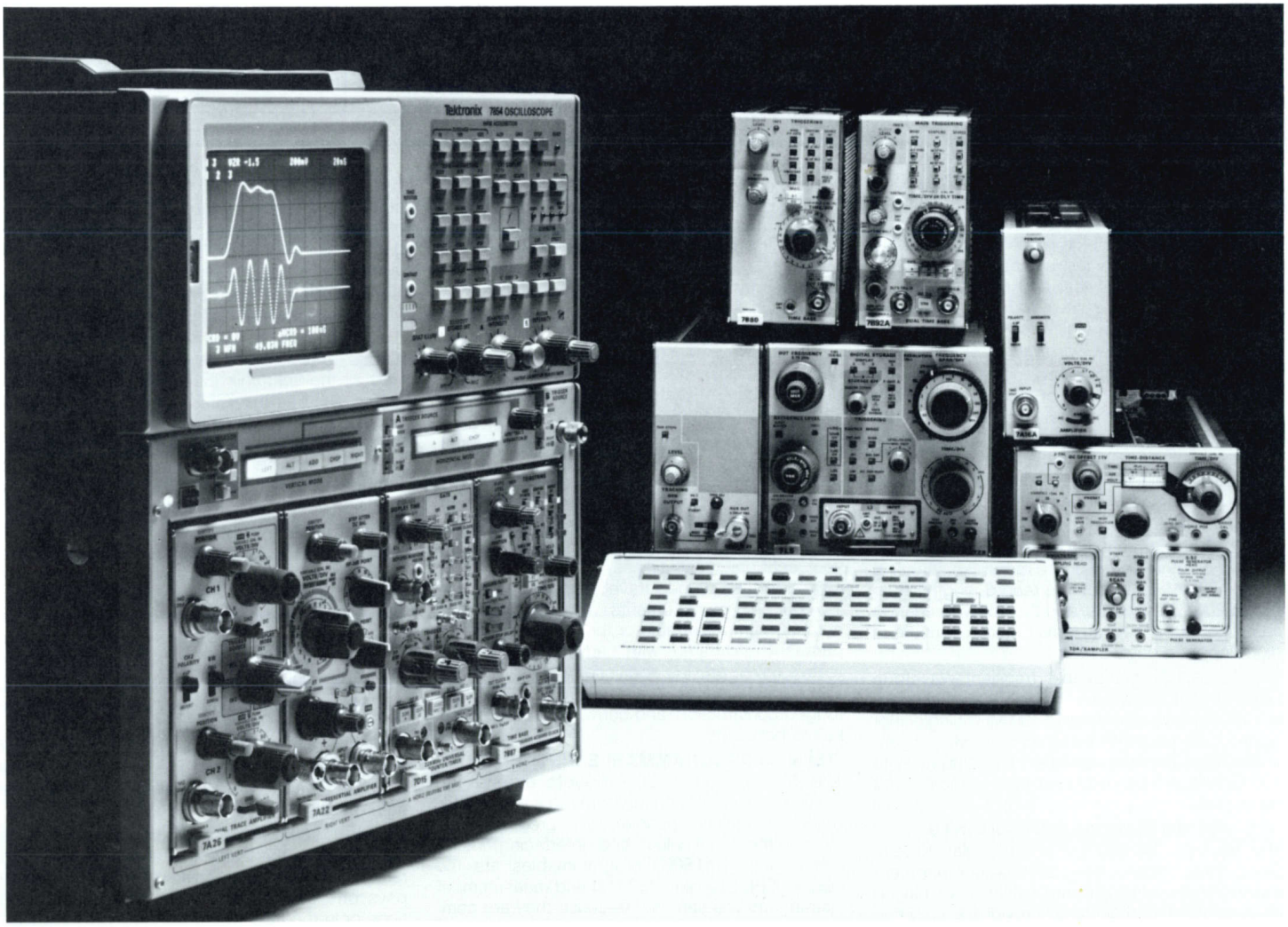
The 7000 Series of plug-in laboratory instruments embodies more state-of-the-art performance features than any other oscilloscope-based measurement system. The 7104 Oscilloscope features a 1 GHz bandwidth combined with the fastest risetime and writing speed available today.

Flexibility

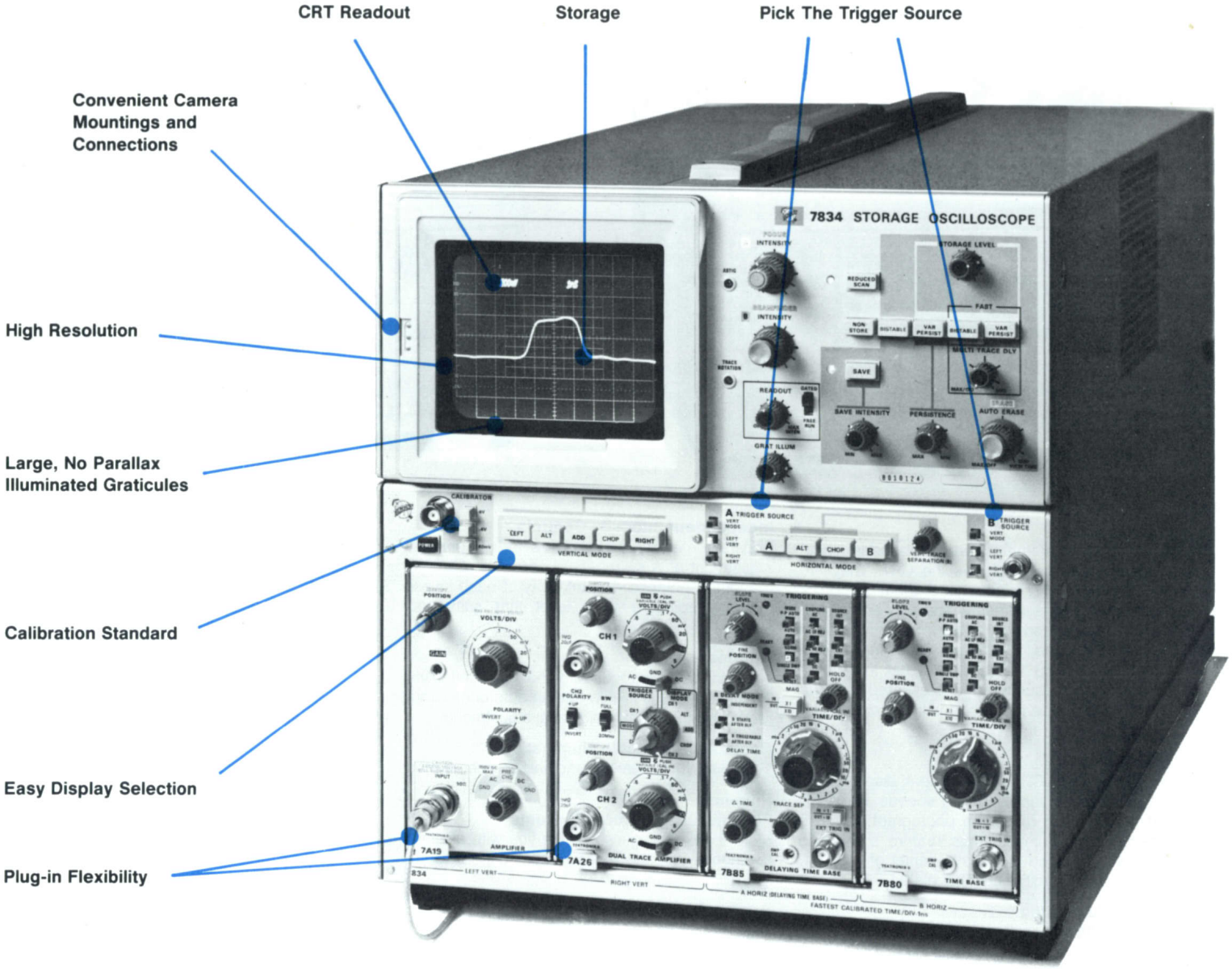
A choice of over 40 plug-ins and 19 mainframes gives you the flexibility to configure the scope package to meet your individual needs. When your needs change, your present package can be reconfigured with a minimum of additional equipment and effort.

Expandability

This assures you that the instrument you buy today will adapt to changing measurement needs, and that it won't become obsolete soon after you buy it. Tektronix' most recent developments in plug-in scope capability are: the Waveform Processing Oscilloscope, the 1 GHz High Writing Rate Oscilloscope, the Programmable Digitizer Plug-In Unit, and the four channel Logic Amplifier.



SUPERIOR PERFORMANCE, FLEXBILITY AND EXPANDABILITY



The 7000 Series is a unique family of instrumentation components, a continuation of the Tektronix commitment to bringing the ultimate in measurement technology to the laboratory.

Numerous measurement concepts—oscilloscopy, synergistic analog-digital measurements, spectrum analysis, sampling, time domain reflectometry, curve tracing—are fused into a family of interdependent CRT (cathode-ray-tube) mainframes and instrumentation plug-ins.

A system can be tailored for your exact measurement needs. Mainframes in the family offer a choice of popular bandwidth ranges and a wide selection of additional features. Plug-ins—including oscilloscope vertical amplifiers and time bases as well as instruments for a variety of applications—can be selected to round out your tailored system.

In opposition to an industrial world that is frequently faulted for planning obsolescence, this instrument family strategically defers obsolescence. Each mainframe and each plug-in reflects the latest technology at its inception, yet each fits a well-planned niche in this interdependent family. The result is an array of instrumentation components that can adapt to our new developments while protecting your initial investment. Today's system may be expanded to meet future needs at a relatively low cost by the addition of a plug-in or two. When the time comes to add a more powerful mainframe, your older model continues to be useful for a host of applications.

CRT Readout*[1]
All significant parameters are displayed in alphanumeric characters right on the CRT. They are readily visible when you need them for quick oscilloscope measurements, and they are permanently recorded on your waveform photographs for future analysis. When your 7000 Series Measurement System includes a digital instrument plug-in, the measurement is presented in clear, accurate digital terms, along with a corresponding analog waveform.

Bright Traces
All 7000 Series CRTs have bright displays and excellent photographic writing speeds. For applications requiring maximum photographic writing speeds, several mainframes feature a reduced scan on a reduced area in the center of the CRT, and one uses a micro-channel plate CRT.

Large, Illuminated and Parallax-Free Graticules
The display area is 8 x 10 divisions (0.85, 0.9, 1.0, or 1.22 cm/div depending upon mainframe) with a parallax-free graticule.

Convenient Camera Mountings and Connections
A standard bezel connector matches all Tektronix oscilloscope cameras to 7000 Series mainframes.

Independent Intensity Controls
Separate intensity controls allow for independent adjustment of A sweep, B sweep, and character readout brightness. The intensity of each sweep may be adjusted to a level that suits your application.

Autofocus
The trace stays in focus with changes in intensity. After the focus is initially set, an autofocus circuit reduces the need for additional adjustments.

Adjustable Graticule Illumination
This gives you easier viewing and sharper photos.

Plug-ins
Flexible Measurement Systems
More than 40 plug-ins provide you with flexibility to choose just the measurement capability you require.

Analog/Digital Synergism
Digital instrumentation plug-ins create unsurpassed measurement capabilities. Highly accurate digital measurements may be made at selectable points on complex waveforms by visually superimposing gate waveforms over signal waveforms.

Mainframes
Calibration Standard
All the 7000 Series calibrators serve as a voltage standard for calibrating vertical plug-ins, a 1 kHz squarewave for adjusting probe compensation, and a 1 kHz frequency standard in the 7800, 7900 and 7100 Series mainframes. The output is available in several 1 kHz squarewave voltages.

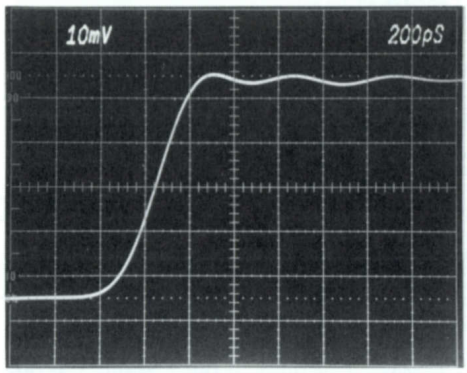
Trigger Source Flexibility
The left and right trigger selector mainframe pushbuttons route the desired trigger source to the appropriate time base. A Vert mode position automatically routes whichever source has been chosen for vertical inputs.

Easy Display Selection
Vertical mode switches allow you to easily select the desired vertical amplifier or interaction of amplifiers (e.g., alternate, chopped, or added modes). Four-compartment mainframes provide equivalent flexibility for time bases as well.

Mainframe Flexibility
Numerous options add even more flexibility in creating the oscilloscope system that most closely meets your measurement requirements.

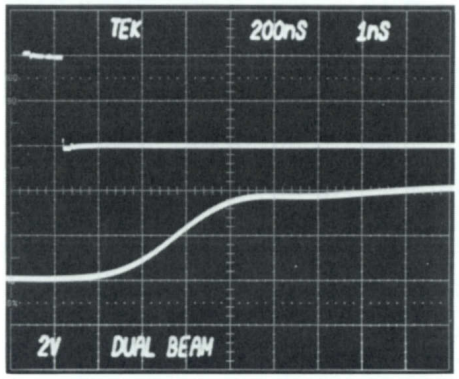
[1] Not available in mainframes or plug-ins with "N" suffix.

Nonstorage 7104



This 300 ps risetime is displayed on a 7104 Nonstorage Oscilloscope. Readout indicates 10 mV/div vertical sensitivity and 200 pS/div sweep speed.

Dual Beam 7844



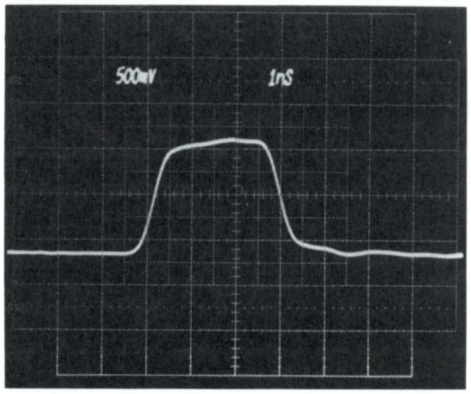
The 400 MHz, dual-beam 7844 Oscilloscope displays one input signal at two sweep speeds (full vertical and horizontal crossover switching). Also provides full overlap on 8 x 10 cm display.

400 MHz Dual-Beam

Dual-beam oscilloscopes, essentially two oscilloscopes in one. Each beam operates separately and independently of the other. They are required for many applications where two transient events must be compared simultaneously. These application areas include stimulation and reaction events in such fields as medicine, biology, chemistry, engineering mechanics, and others.

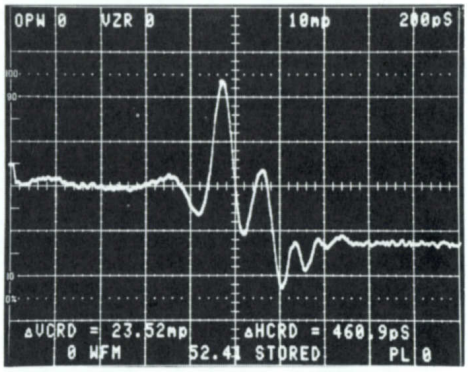
Depending on the plug-ins selected, up to eight traces can be displayed at a time.

CRT Storage



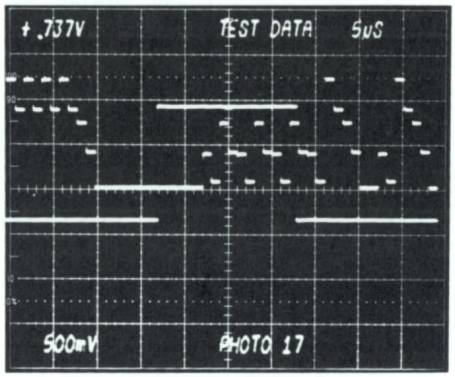
Readout is stored with the waveform on several CRT storage scopes including the 7613, 7623A, 7633 and 7834. Multimode storage is available on the 7623A, 7633, and 7834.

Sampling/Time Domain Reflectometry



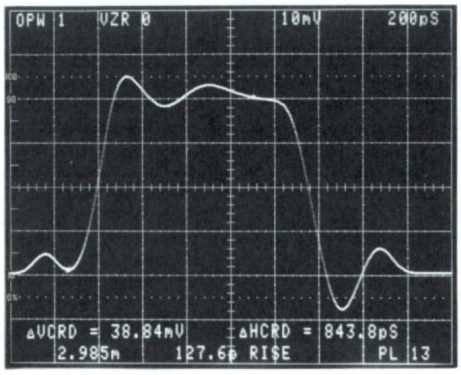
7854 Digital Oscilloscope with 7S12 Plug-in provides digital processing capability for sampling and time domain reflectometry.

Digital Readout Measurements



7854 Digital Oscilloscope with 7D12/M2 Plug-in measures +0.737 volts difference between two points on complex waveform. Gate waveform indicates leading and trailing edges where voltage difference is measured.

Digital Storage 7854



Store Repetitive Signals up to 400 MHz with Standard Plug-ins, and up to 14 GHz with the 7S12 Sampler, Digital Storage with Waveform Processing, Common Waveform Measurements at the Touch of a Button, Keystroke Programming, GPIB Interface

Digital Measurement Plug-ins

The 7000 Series digital plug-ins include: A universal counter/timer, digital multimeter with temperature mode, digital delay by time or events, a versatile 0.01% A/D converter with vertical amplifier, and a special read-out unit to label each test for future reference. Together with a 7000 Series mainframe, these give you the advantage of seeing what you're measuring, plus accuracy of digital techniques.

This combination offers many advantages over separate test units. You get: scope-controlled digital measurements, measuring convenience and confidence, increased accuracy, easier and faster solutions to complex problems, a lower dollar investment, more bench space and signal conditioning.

Sampling

The 7000 Series sampling plug-ins provide some unique measurement capabilities not available in other sampling oscilloscopes. You get: a low-cost storage CRT for slow scans, a random mode that lets you see leading edges without pretrigger or bandwidth-limiting delay line, a wide choice of sampling heads at minimal cost, and the convenience of sampling and conventional displays at the same time on the CRT.

The adjacent sampling waveform shows the power of the 7S12 TDR Plug-in with the 7854 Digital Storage Oscilloscope. First, the 7854 acquired the TDR signal from a prototype connector design, using waveform averaging to eliminate noise on the trace. Then, positioning the 7854 cursors to the area of interest on the waveform, the internal 7854 program calculates an impedance of 52.41 Ω at the discontinuity.

Spectrum Analysis

Unexcelled plug-in performance from 20 Hz to 60 GHz is provided by the 7L5, 7L14 and 7L18 Spectrum Analyzers. Stable, sensitive and spurious-free, these analyzers work in any 7000 Series mainframe. The same mainframe may be used with other plug-ins for oscilloscope measurements.

Some plug-in analyzers have microprocessor-aided controls for easy operation, and digital storage and display capability for recalling and comparing signals. Others offer 30 Hz resolution for viewing close-together signals. Some optional tracking generators are available for swept frequency measurements.

Refer to the Spectrum Analyzer section beginning on page 209 for more information.

CRT Storage see page 255.

Digitizers see page 336.

7000 SERIES OSCILLOSCOPE SYSTEMS/PROBE SELECTION CHART*1

		PASSIVE VOLTAGE 1 MΩ INPUT COMPATIBLE							PASSIVE VOLTAGE 50 Ω INPUT COMPT		FET PROBES 50 Ω/1 MΩ INPUT COMPATIBLE			CURRENT PROBES		
PROBE		**P6101** 1 Meter	**P6130** 1.5 Meter **P6106** 1 Meter	**P6055*2** 3.5 ft	**P6009** 9 ft	**P6015** 10 ft	**P6062B** 6 ft	**P6122** 1.5 Meter **P6105** 2 Meter	**P6056** 1.5 Meter	**P6057** 6 ft	**P6202A*4** 2 Meter	**P6046** 6 ft	**P6201*4** 6 ft	**P6021** w/passive term, 5 ft 10 mV/mA	**P6022** w/passive term, 5 ft 10 mV/mA	**P6302/** AM 503 6 ft
FEATURES		Miniature Probe	Fastest Probes Compatible with 1-MΩ Input	Adj Attenuation for Differential Use	1.5 kV	40 kV Pk Pulse	Selectable Attenuation 1X:10X	Minature Probes	Fastest 10X Passive Probe Low C	Fastest 100X Passive Probe Low C	10-MΩ Input Impedance Dc Offset	Differential Probe High CMRR	Low Capacitive LoadingAc Coupling Dc Offset	Ac High Current	Ac High Frequency	Dc High Current
ATTENUATION		1X	10X	10X	100X	1000X	Selectable	10X	10X	100X	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable
7104	**7A19**	Nc	Nc	Nc	Nc	Nc	Nc	Nc	500 MHz	480 MHz	300 MHz	100 MHz	430 MHz	Nc	Nc	50 MHz
	7A24	Nc	Nc	Nc	Nc	Nc	Nc	Nc	350 MHz	350 MHz	300 MHz	100 MHz	310 MHz	Nc	Nc	45 MHz
	7A26	34 MHz	175 MHz		125 MHz	75 MHz		100 MHz			185 MHz	90 MHz	195 MHz	60 MHz	140 MHz	50 MHz
	7A29	Nc	Nc	Nc	Nc	Nc	Nc	Nc	950 MHz	800 MHz	450 MHz	100 MHz	660 MHz	Nc	Nc	50 MHz
7900 FAM-ILY	**7A11*1**	Nc	Nc	Nc	Nc	Nc		Nc						55 MHz	150 MHz	45 MHz
	7A13	34 MHz	105 MHz	65 MHz	85 MHz	65 MHz		75 MHz		105 MHz	105 MHz	70 MHz	105 MHz	50 MHz	90 MHz	45 MHz
	7A15A	34 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz		80 MHz	80 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A16A	34 MHz	200 MHz		130 MHz	80 MHz				205 MHz	205 MHz	90 MHz	215 MHz	55 MHz	150 MHz	45 MHz
	7A18A	34 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz		75 MHz	75 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A19	Nc	Nc	Nc	Nc	Nc	Nc	Nc	500 MHz	480 MHz	300 MHz	95 MHz	430 MHz	Nc	Nc	50 MHz
	7A22	1 MHz	Nc	1 MHz			1 MHz							1 MHz	1 MHz	1 MHz
	7A24	Nc	Nc	Nc	Nc	Nc	Nc	Nc	350 MHz	350 MHz	290 MHz	90 MHz	310 MHz	Nc	Nc	45 MHz
	7A26	34 MHz	175 MHz		125 MHz	75 MHz					185 MHz	85 MHz	180 MHz	55 MHz	140 MHz	45 MHz
7800 FAM-ILY	**7A11**	Nc	Nc	Nc	Nc	Nc	Nc	Nc						55 MHz	130 MHz	45 MHz
	7A13	34 MHz	95 MHz	65 MHz	85 MHz	60 MHz		100 MHz			100 MHz	70 MHz	100 MHz	50 MHz	85 MHz	45 MHz
	7A15A	34 MHz	75 MHz		70 MHz	55 MHz	75 MHz	75 MHz			80 MHz	60 MHz	80 MHz	45 MHz	70 MHz	40 MHz
	7A16A	34 MHz	160 MHz		110 MHz	75 MHz		100 MHz			170 MHz	85 MHz	165 MHz	55 MHz	130 MHz	45 MHz
	7A18A	34 MHz	85 MHz		80 MHz	60 MHz	85 MHz	85 MHz			75 MHz	65 MHz	90 MHz	45 MHz	70 MHz	40 MHz
	7A19	Nc	Nc	Nc	Nc	Nc	Nc	Nc	400 MHz	400 MHz	320 MHz	95 MHz	360 MHz	Nc	Nc	50 MHz
	7A22	1 MHz	Nc	1 MHz	1 MHz	1 MHz	1 MHz	1 MHz						1 MHz	1 MHz	1 MHz
	7A24	Nc	Nc	Nc	Nc	Nc	Nc	Nc	300 MHz	300 MHz	270 MHz	90 MHz	280 MHz	Nc	Nc	45 MHz
	7A26	34 MHz	145 MHz		105 MHz	75 MHz		100 MHz			150 MHz	85 MHz	155 MHz	55 MHz	125 MHz	45 MHz
7704A	**7A11**	Nc	Nc	Nc	Nc	Nc	Nc	Nc						55 MHz	125 MHz	45 MHz
	7A13	34 MHz	100 MHz	65 MHz	85 MHz	65 MHz		70 MHz			100 MHz	70 MHz	100 MHz	50 MHz	85 MHz	40 MHz
	7A15A	34 MHz	70 MHz		65 MHz	55 MHz	70 MHz	70 MHz			75 MHz	55 MHz	70 MHz	45 MHz	70 MHz	40 MHz
	7A16A	34 MHz	145 MHz		115 MHz	75 MHz		100 MHz			160 MHz	80 MHz	150 MHz	55 MHz	125 MHz	45 MHz
	7A18A	34 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz			75 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A19*3	Nc	Nc	Nc	Nc	Nc	Nc	Nc	250 MHz	250 MHz	220 MHz	85 MHz	215 MHz	Nc	Nc	45 MHz
	7A22	1 MHz	Nc	1 MHz			1 MHz	1 MHz						1 MHz	1 MHz	1 MHz
	7A24	Nc	Nc		Nc	Nc	Nc	Nc	200 MHz	200 MHz	185 MHz	80 MHz	180 MHz	Nc	Nc	45 MHz
	7A26	34 MHz	140 MHz		105 MHz	75 MHz		100 MHz			160 MHz	80 MHz	140 MHz	55 MHz	115 MHz	45 MHz
7600 FAM-ILY	**7A11**	Nc	Nc	Nc	Nc	Nc	Nc	Nc						50 MHz	85 MHz	40 MHz
	7A13	34 MHz	75 MHz	55 MHz	60 MHz	55 MHz	70 MHz	70 MHz			75 MHz	55 MHz		45 MHz	70 MHz	40 MHz
	7A15A	34 MHz	60 MHz		55 MHz	50 MHz	60 MHz	60 MHz			65 MHz	50 MHz		40 MHz	60 MHz	35 MHz
	7A16A	34 MHz	95 MHz		85 MHz	65 MHz	95 MHz	95 MHz			100 MHz	70 MHz		50 MHz	85 MHz	40 MHz
	7A18A	34 MHz	70 MHz		65 MHz	55 MHz	70 MHz	70 MHz			75 MHz	55 MHz		45 MHz	70 MHz	40 MHz
	7A22	1 MHz	Nc	1 MHz			1 MHz	1 MHz						1 MHz	1 MHz	1 MHz
	7A26	34 MHz	95 MHz		85 MHz	65 MHz	95 MHz	95 MHz			100 MHz	70 MHz		50 MHz	85 MHz	40 MHz

*1 *The values in the above table represent the approximate useful frequency response for the measurement systems at the probe tip.*

*2 *015-0437-00 Matched pair recommended*
*3 *Option 09 Mainframe*
*4 *Requires 1101 Power Supply or other external source of power when used with 7854, 7603, 7633, 7623, or 7613.*

Nc = Not compatible
If there is no bandpass specified, the probe/plug-in combination is compatible but not recommended.

7000 SERIES MAINFRAME/TIME BASE RECOMMENDATIONS

MAINFRAME		**7104**	**7904A R7903**	**7844/R 7834**	**7854**	**7704A R7704**	**7603/R**	**7603N11**	**7623A/R**	**7613/R**
TIME BASE	**PERFORMANCE FEATURE**	• INDICATES RECOMMENDED COMBINATION								
7B50A	Single time base						•	•*2	•	•
7B53A	Dual time base with mixed sweep						•	•*2		•
7B53A Option 05	7B53A with TV sync triggering				•*3		•	•*2	•	•
7B80	Single time base (used also as delayed time base)		•	•	•*3	•				
7B85	Single time base with delaying and Δ delay sweep function		•	•	•*3	•*1				
7B87	Pretrigger and single shot digitizing				•					
7B92A	Dual time base with display switching		•	•	•*3	•*1				
7B10	Single time base (used also as delayed time base)	•	•	•	•*3	•				
7B15	Single time base with delaying and Δ delay sweep function	•	•	•	•*3	•*1				

*1 *No trace separation on R7704 only.* *2 *No mainframe readout.* *3 *Full capabilities of 7854 not achievable with this time base.*

7000 SERIES MAINFRAMES AND PLUG-INS DIMENSIONS AND WEIGHTS

Dimensions		**7612D**	**7912AD**	**7854*1**	**7104**	**7904A**	**R7903**	**7844**	**R7844**	**7834**	**7704A**	**R7704**	**7603**	**R7603**	**7603NMS**	**7633, 7623A, 7613**	**R7633, R7623A, R7613**	**Plug-Ins Single**	**Plug-Ins Double**
Width	mm	483	483	305	305	305	483	305	483	305	305	483	221	483	246	221	483	7.1	140
	in	19.0	19.0	12.0	12.0	12.0	19.0	12.0	19.0	12.0	12.0	19.0	8.7	19.0	9.7	8.7	19.0	2.8	5.5
Height	mm	178	178	348	345	345	135	328	178	345	345	178	290	133	292	305	133	127	127
	in	7.0	7.0	13.7	13.6	13.6	5.3	12.9	7.0	13.6	13.6	7.0	11.4	5.3	11.5	12.0	5.3	5.0	5.0
Depth	mm	679	679	627	592	577	579	605	630	589	577	569	610	627	640	597	566	368	368
	in	26.8	26.8	24.7	23.3	22.7	22.8	23.8	24.8	23.2	22.7	22.4	24.0	24.7	25.2	23.5	22.3	14.5	14.5
Weights ≈																			
Net	kg	25.0	22.7	20.4	19.8	16.9	12.3	16.3	15.0	16.1	13.6	20.0	13.6	13.6	20.4	13.6	14.5	0.9	4.1
	lb	55.0	50.0	45.0	43.6	37.2	27.0	36.0	33.0	35.5	30.0	44.0	30.0	30.0	45.0	30.0	32.0	2.0	9.0
Shipping	kg		32.6	28.1	25.4	22.4	23.6	21.3	28.5	21.3	19.5	35.0	20.8	28.2	32.7	19.0	28.2	2.3	5.4
	lb		72.0	62.0	56.0	49.2	52.0	47.0	63.0	47.0	43.0	77.0	46.0	62.0	72.0	42.0	62.0	5.0	12.0

*1 *Calculator dimensions and weights, width 277 mm (10.9 in), height 69 mm (2.7 in), depth 165 mm (6.5 in).*

7000 SERIES VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER		7A11	7A13	7A15A	7A16A	7A17	7A18A	7A19	7A22	7A24	7A26	7A29	7A42
PAGE		265	266	263	263	265	264	263	267	264	264	263	268
Performance Feature		Low-capacitance FET probe amplifier	Differential dc offset, high-freq CMRR amplifier	Low cost conventional input amplifier	Wide bandwidth conventional input amplifier	Low cost, easy to customize amplifier	Dual-channel amplifier	Wide bandwidth 50 Ω input amplifier	Dc-coupled, high-gain differential amplifier	Dual-channel 50 Ω amplifier	Dual-channel amplifier	Widest Bandwidth Single Channel	Four-channel Logic Triggered
Minimum Deflection Factor		5 mV/div	1 mV/div	5 mV/div (0.5 mV/div)*2	5 mV/div	50 mV/div	5 mV/div	10 mV/div	10 μV/div	5 mV/div	5 mV/div	10 mV/div	20 mV/div
Accuracy*1 Without Probe		2% (integral)	1.5%	2%	2%	—	2%	3%	2%	2%	2%	2%	3%
7104 0 to 35°C	BW	250 MHz	100 MHz P6130 100 MHz P6106*9 65 MHz P6055	80 MHz	225 MHz	150 MHz	75 MHz	600 MHz	1 MHz ± 10%	400 MHz	200 MHz	1000 MHz	350 MHz
	Tr	1.4 ns	3.5 ns P6130 3.5 ns P6106*9 5.4 ns P6055	4.4 ns	1.6 ns	2.4 ns	4.7 ns	0.6 ns	± 350 ns ± 9%	0.9 ns	1.8 ns	0.38 ns	1.0 ns
7904A **R7903** **7912AD*3,*8** 0 to 30°C	BW	250 MHz	105 MHz P6130 105 MHz P6106*9 65 MHz P6055	80 MHz	225 MHz	150 MHz	75 MHz	500 MHz	1 MHz ± 10%	350 MHz	200 MHz	500 MHz	300 MHz
	Tr	1.4 ns	3.4 ns P6130 3.4 ns P6106*9 5.4 ns P6055	4.4 ns	1.6 ns	2.4 ns	4.7 ns	0.8 ns	350 ns ± 9%	1.0 ns	1.8 ns	0.7 ns*10	1.2 ns
	SIG OUT BW	140 MHz	100 MHz P6130 100 MHz P6106*9 65 MHz P6055	70 MHz	140 MHz	15 MHz	70 MHz	300 MHz	1 MHz ± 10%	140 MHz	140 MHz	300 MHz	NA
7844/R 0 to 35°C	BW	200 MHz	100 MHz P6130 100 MHz P6106*9 65 MHz P6055	80 MHz	200 MHz	150 MHz	75 MHz	400 MHz*4	1 MHz ± 10%	300 MHz	180 MHz	400 MHz	275 MHz
	Tr	1.8 ns	3.5 ns P6130 3.5 ns P6106*9 5.4 ns P6055	4.4 ns	1.8 ns	2.4 ns	4.7 ns	0.9 ns	350 ns ± 9%	1.2 ns	1.9 ns	0.9 ns	1.3 ns
7854*7 **7834** 0 to 35°C	BW	200 MHz	95 MHz P6130 95 MHz P6106*9 65 MHz P6055	80 MHz	200 MHz	150 MHz	75 MHz	400 MHz*4	1 MHz ± 10%	300 MHz	180 MHz	400 MHz	275 MHz
	Tr	1.8 ns	3.7 ns P6130 3.7 ns P6106*9 5.4 ns P6055	4.4 ns	1.8 ns	2.4 ns	4.7 ns	0.9 ns	350 ns ± 9%	1.2 ns	1.9 ns	0.9 ns	1.3 ns
7704A **Opt 09** 0 to 30°C	BW	170 MHz	100 MHz P6130 100 MHz P6106*9 65 MHz P6055	75 MHz	170 MHz	150 MHz	75 MHz	250 MHz*5	1 MHz ± 10%	200 MHz	170 MHz	250 MHz	180 MHz
	Tr	2.1 ns	3.5 ns P6130 3.5 ns P6106*9 5.4 ns P6055	4.7 ns	2.1 ns	2.4 ns	4.7 ns	1.5 ns	350 ns ± 9%	1.8 ns	2.1 ns	1.5 ns	1.9 ns
	SIG OUT BW	70 MHz	60 MHz P6130 60 MHz P6106*9 50 MHz P6055	55 MHz	70 MHz	15 MHz	55 MHz	80 MHz	1 MHz ± 10%	70 MHz	70 MHz	80 MHz	NA
7704A 0 to 50°C	BW	170 MHz	100 MHz P6130 100 MHz P6106*9 65 MHz P6055	75 MHz	160 MHz	150 MHz	75 MHz	200 MHz	1 MHz ± 10%	200 MHz	150 MHz	200 MHz	175 MHz
	Tr	2.1 ns	3.5 ns P6130 3.5 ns P6106*9 5.4 ns P6055	4.7 ns	2.2 ns	2.4 ns	4.7 ns	1.8 ns	350 ns ± 9%	1.8 ns	2.4 ns	1.8 ns	2.0 ns
	SIG OUT BW	70 MHz	60 MHz P6130 60 MHz P6106*9 50 MHz P6055	55 MHz	70 MHz	15 MHz	55 MHz	80 MHz	1 MHz ± 10%	70 MHz	70 MHz	80 MHz	NA
R7704 0 to 50°C	BW	150 MHz	100 MHz P6130 100 MHz P6106*9 65 MHz P6055	75 MHz	150 MHz	150 MHz	75 MHz	175 MHz	1 MHz ± 10%	160 MHz	140 MHz	175 MHz	150 MHz
	Tr	2.4 ns	3.5 ns P6130 3.5 ns P6106*9 5.4 ns P6055	4.7 ns	2.4 ns	2.4 ns	4.7 ns	2.0 ns	350 ns ± 9%	2.2 ns	2.5 ns	2.0 ns	2.3 ns
	SIG OUT BW	60 MHz	55 MHz P6130 55 MHz P6106*9 45 MHz P6055	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	1 MHz ± 10%	60 MHz	60 MHz	65 MHz	NA
7603/R **7633/R** 0 to 50°C	BW	100 MHz	75 MHz P6130 75 MHz P6106*9 55 MHz P6055	65 MHz	100 MHz	100 MHz	75 MHz	100 MHz	1 MHz ± 10%	100 MHz	100 MHz	100 MHz	100 MHz
7623A/R **7613/R** 0 to 50°C	Tr	3.5 ns	5.0 ns P6130 5.0 ns P6106*9 6.4 ns P6055	5.4 ns	3.5 ns	3.5 ns	4.7 ns	3.5 ns	350 ns ± 9%	3.5 ns	3.5 ns	3.5 ns	3.5 ns
7603N11*6 0 to 50°C	SIG OUT BW	60 MHz	55 MHz P6130 55 MHz P6106*9 45 MHz P6055	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	1 MHz ± 10%	60 MHz	60 MHz	65 MHz	NA
7612D*8 0 to 40°C	BW	80 MHz	65 MHz	60 MHz	80 MHz		65 MHz	80 MHz	1 MHz ± 10%	80 MHz	80 MHz	80 MHz	80 MHz
	Tr (Calculated)	5.0 ns	6.0 ns	6.7 ns	5.0 ns		6.0 ns	5.0 ns	350 ns ± 9%	5.0 ns	5.0 ns	5.0 ns	5.0 ns

*1 *Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. When a probe is used, the gain must be set with the calibration signal applied to the probe tip. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%.*

*2 *Obtained with 10X gain at reduced bandwidth of 10 MHz.*

*3 *Refer to Transient Digitizer, 7912AD not available with signal outputs.*

*4 *Bandwidth is 325 MHz to 10 mV/div.*

*5 *Bandwidth is 200 MHz at 10 mV/div.*

*6 *All 7000 Series plug-ins are compatible with the 7603N Opt 11. However, they do not meet the rigid environmental specification required by the military.*

*7 *Bandwidth with equivalent time sampling and time display only.*

*8 *Fully programmable mainframe. 7A16P Programmable Amplifier recommended. 7A16P provides 200 MHz, 1.8 ns in 7912AD and 80 MHz, 5.0 ns in 7612D, see page 327.*

*9 *P6106 has Ground Reference*

*10 *R7903 with 7A29 Tr is 0.8 ns.*

TEK Lab Cart Model 3

Model 3 Lab Cart accepts all 7000 Series oscilloscopes. A lockable drawer for storage and a movable shelf for additional instrumentation are included. The shelf accepts TM 500 Test and Measurement Instruments, 5000 Series oscilloscopes, or 400 Series oscilloscopes.

For full details see SCOPE-MOBILE® Cart section, page 432.

SUMMARIZED CAMERA CHARACTERISTICS

RECOMMENDED CAMERA	OSCILLOSCOPES	PERFORMANCE FEATURES AND BENEFITS	LENS				FILM BACKS		PAGE
			MAXIMUM RELATIVE APERTURE	MAG	RELATIVE SPEED*1	FIELD OF VIEW (with 3.25 x 4.25 in Polaroid Film except where noted)	STANDARD BACK	OPTIONAL AND INTERCHANGEABLE	
C-51P*2	7904A, R7903, 7844, 7854 R7704, 7704A	Fastest writing speed with 0.5 mag lens	f/1.2	0.5	3.0	8 x 10 cm/ 3.15 x 3.93 in	Polaroid Pack	4 x 5 in Graflok*3 (C-51G)	428
C-53P*2	All except 7603 7603N11S	General-purpose with 0.85 mag lens	f/1.9	0.85	1.0	8 x 10 cm/ 3.15 x 3.93 in	Polaroid Pack	4 x 5 in Graflok*3 (C-53G)	428
C-59AP*2	7603 7603N11S	General-pupose for 6½ in CRT's	f/2.8	0.67	0.65	10.2 x 12.7 cm/ 4 x 5 in	Polaroid Pack	4 x 5 in Graflok*3 (C-59AG)	429
C-5C	All except 7603/7603N11S	Low cost for repetitive waveforms	f/16	0.67 or 0.85 selectable	0.02	9.76 x 12.2 cm	Polaroid Pack	None	426
C-5C Option 01	7603/7603N11S								

**1 Relative light-gathering power.*
**2 C-50 Series Camera Adaptor, part number 016-0249-03, included with camera. For full details see camera section, page 424.*
**3 Requires optional film holder, i.e. 4 x 5 in, 120 mm, 70 mm, or sheet film.*

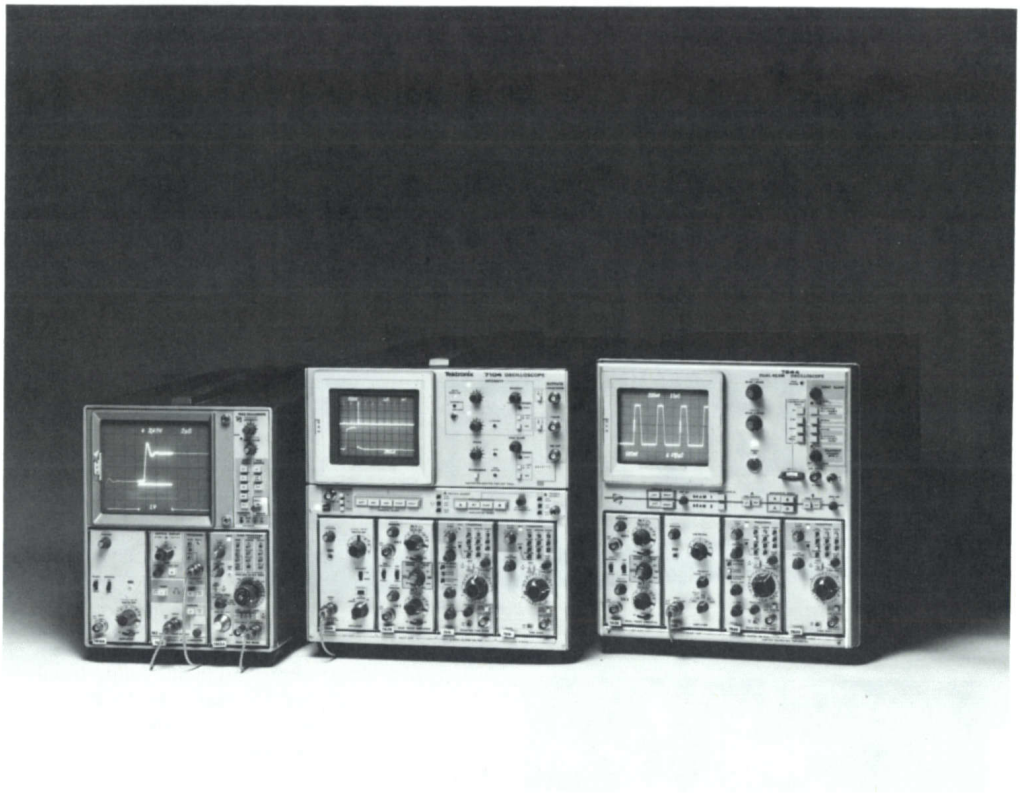
CURRENT APPLICATION NOTES FOR 7000 SERIES*1

Title	Featuring	Part No
PULSE ECHO MEASUREMENTS with digital accuracy	7603/7A22/7D15/7B53A Timing measurements between nonadjacent pulses. Ultrasonic transducers	42AX-3681-1
X-Y DISPLAYS with interval timing for measuring SOA	7D15/7A18/7A22 X-Y power dissipation measurements	42AX-3957
DAC MEASUREMENTS: The sampling oscilloscope approach	7S14/7D12/M2/7B92A/7904 Measuring DAC (digital analog converter settling time	42AX-3632-1
SCR GATING WAVEFORM MEASUREMENTS with high-resolution digital accuracy	7D12/M2/7A16A (four compartment mainframes) SCR measurements. Absolute and relative (two point) voltage monitoring	42AX-2693-1
Accurate Radar Pulse Measurements	7D11 The measurement of radar pulse delay time is given as an example of 7D11 operation	AX-2659-3
Measuring time interval between non-adjacent digital word train pulses or multiecho radar pulses	7D15 Demonstrates the ability of the 7D15 to measure the time between adjacent pulses with digital counter accuracy	42W-2680-3
Measuring memory core I/O signals with digital accuracy	7000 Series Digital Plug-ins Demonstrates how digital plug-ins can be used to make accurate pulse parameter measurements both of amplitude and pulse timing	42AX-2686-1
Measuring disc drive time and access voltages with Tektronix 7000 Series Digital Plug-ins	7000 Series Digital Plug-ins Use a single CRT display to perform both digital and analog analysis of complex waveforms	42AX-2687-2

Title	Featuring	Part No
MEASUREMENT VARIETY An Engineering challenge featuring the 7854	7854/Waveform Calculator Demonstrating basic operation, application software for percent overshoot, data monitoring and histogram.	42AX-4281
GPIB COMMUNICATION with the 7854	7854/4052 and 7854/4924 Types of I/O transfers, transmission formats, and operational software in TEK Basic compatible with any 4050 Series computer	42AX-4416-1
Pulse and digital timing measurements—a better technique	7B80/7B85 General overview of the operation of the 7B85 and 7B80 Delta-Time Measurement Plug-ins	42AX-3379-1
Using storage to find troublesome logic glitches	7633 Shows how the 7633 Storage Oscilloscope can be used to capture and evaluate glitches	42AX-3085
Variable persistence storage applications	7613/5441 Describes various applications for variable persistence storage oscilloscopes	42AX-3198
Bistable storage applications	Tektronix Storage Oscilloscopes. Describes various applications for bistable storage oscilloscopes	42AX-3199

**1 Check with your local sales office for availability and other application notes not listed.*

7000 SERIES NONSTORAGE MAINFRAMES



CONTENTS

7104 1 GHz General Purpose 244
7904A/R7903 500 MHz General Purpose 246
7704A/R7704 200 MHz General Purpose 248
7603/R7603 100 MHz General Purpose 250
7603N11S Ruggedized Oscilloscope System 252
7844/R7844 400 MHz Dual Beam 254

A high performance instrument system begins with the basic oscilloscope building block — the 7000 Series Mainframe. Each mainframe consists of a cathode-ray tube, a power supply, electron beam deflection systems, and the switching circuitry necessary to integrate a versatile and complete measurement system.

The Tektronix 7104 is a 1 GHz oscilloscope featuring the fastest risetime (350 ps) and writing speed (20 cm/ns) available today.

Choose from a variety of features, including bandwidth, dual-beam, alphanumeric displays, rackmounting, and three- or four-plug-in flexibility.

7104

Ultra High Photographic Writing Speed — at Least 20 cm/ns

1 GHz at 10 mV/div

350 ps Risetime

200 ps/div Fastest Calibrated Sweep Rate

Horizontal Bandwidth 350 MHz

Phase Compensation Option—Phase Matching to 250 MHz

CRT Readout

APPLICATIONS

- **High Speed Semiconductor Design**
- **Laser and High Energy Research**
- **Digital Communications**

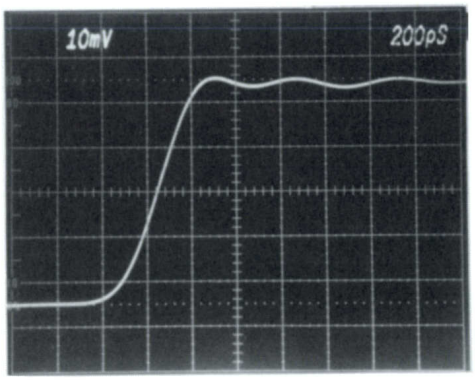
With its sweep speed of 200 ps/div, the 7104 clearly shows a single-shot, 350-ps step, six divisions in amplitude.

The capabilities of the 7104 are of substantial value in numerous high technology environments.

The 7104 has both the highest writing speed and highest bandwidth available in a general-purpose oscilloscope today.

It is by no means unusual to see 250 MHz data rates and 900 MHz analog frequencies outside the lab and on the production line. In digital design, too, anomalies such as ringing and overshoot can only be dealt with by evaluating the signal's analog characteristics.

You can capture the fastest transients without expensive high-speed film or other time consuming and complex techniques like fogging or reducing the scan. In fact, you can see those signals on the CRT, and eliminate costly time consuming photographs.

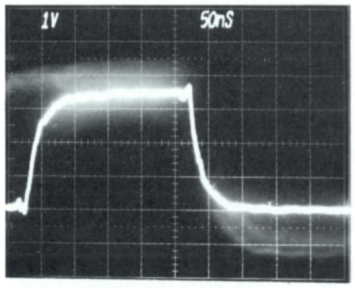


The 7104 with 7A29 Amplifier plug-ins provides 1 GHz real-time vertical bandwidth at 10 mV/div. Combined with the 7B10/7B15 Time Base plug-ins, having fastest sweep speeds of 200 ps/div, very high-speed signals can now be measured with confidence.

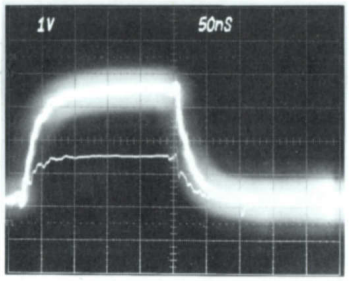
The 7104's outstanding writing speed means unsurpassed single-shot capability, with trace brightness about **one-thousand** times that of conventional oscilloscopes. Any single-shot signal within the 7104's bandwidth can be seen directly on the CRT in average room light. Also, single-shot photography is now simple and straightforward, using standard oscillographic cameras and film without high-speed enhancement techniques.

Horizontal bandwidth of 350 MHz, with the X-Y phase compensation Option 02, gives accurate X-Y displays to 250 MHz. Designers can now directly obtain V-I curves for high-speed switching power supply evaluation or monitor performance of digital communication systems using phase constellation displays.

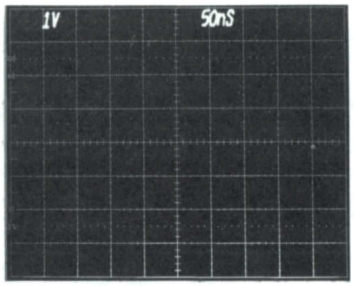
SEE WHAT YOU COULD NEVER SEE BEFORE.



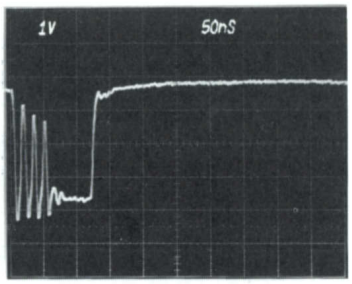
***Before** — A pulse train on a TEK 7904 doesn't reveal the low-level glitch occurring every ten-thousandth pulse. (The TEK 7904 was previously the world's fastest-writing-rate scope.)*



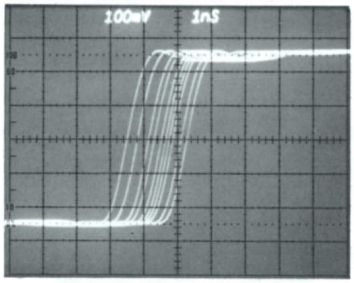
***After** — The same pulse train viewed directly on the 7104, with one-thousand times the brightness of conventional scopes. The researcher can now analyze the pulse with the naked eye and take pictures with ease.*



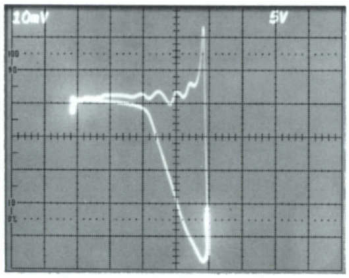
***Before** — Low rep-rate pulse is invisible on a conventional oscilloscope.*



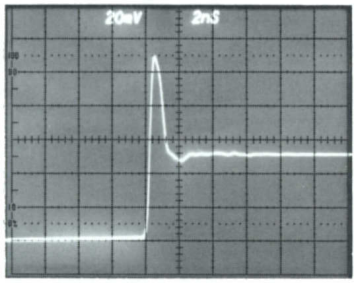
***After** — The same pulse as seen on the 7104 readily indicates that the problem is input signal bounce.*



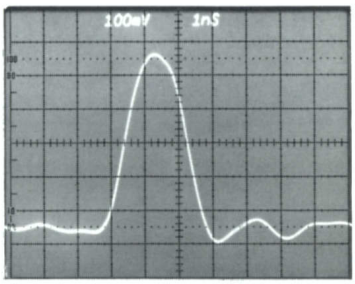
A digital circuit that shows no jitter on a conventional oscilloscope is found to have a 2.0 ns jitter when viewed with the distinct image viewing capability of the 7104.



The transient load line of a fast switching transistor in a power supply prototype (switching time=10 ns) is easily measured for compliance with safe operating area. (Horizontal=V; vertical=I).



Circuit faults such as high frequency pulse overshoot and ringing can easily be observed with the 7104's 1 GHz bandwidth.



View of a single clocking pulse 0.8 ns rise and 2 ns pulse width.

CHARACTERISTICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit.
Vertical Display Modes — Left, Alt, Add, Chop, Right.
Chopped Mode — Rep rate is ≈1 MHz.
Vertical Trace Separation — Operative when any vertical signal is displayed with both A and B time bases. Positions B trace at least 4 divisions above and below A trace.
Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments; compatible with the time bases of the 7B10 and 7B80 Series and the 7B50A and 7B92A. The 7B50 Series (except the 7B50A), the 7B70 Series and the 7B92 (non-A) are not recommended. 7000 Series vertical amplifiers and specialized plug-ins may also be used.
Horizontal Display Modes — A, Alt, Chop, B.
Fastest Calibrated Sweep Rate — 200 ps/div with the 7B10 or 7B15.
Chopped Mode — Rep rate is ≈200 kHz.
Bandwidth — Dc to 350 MHz. With delay compensation (7104 Option 02 using 7A19s or 7A29s, at least one of which has the Variable Delay Option, B Horizontal compartment only), within 2° from dc to 50 MHz after adjusting variable delay for balance at 35 MHz. Phase balance can be obtained at any frequency up to 250 MHz. Phase shift is within 2° from dc to 50 kHz without delay compensation.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 division (0.85 cm/div) graticule with variable illumination. Accelerating potential is 12.5 kV with GH (P31) Phosphor standard.
Readout and Graticule Modes — Each continuous or pulsed (pulse source selecton by front panel controls: +Gate, external, manual). The pulsed graticule is on for ≈0.5 s.
Mininum Photographic Writing Speed (using Polaroid Film Type 107, 3000 ASA w/out Film Fogging) — 20 cm/ns (w/o blue filter). Phosphor: GH (P31) standard. Camera: Tektronix C-53, f/1.9, 1:0.85 lens.
Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.
Beam Finder — Limits display within graticule area.
External Z-Axis Input — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

CALIBRATOR

Voltage Output — Squarewave positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; rep rate is 1 kHz within 0.25%.
Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

EMC MODIFICATIONS (OPTION 03)

Meets requirements of MIL-STD-461A, when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

OUTPUTS/INPUTS

+Sawtooth — User selectable from A or B horizontal. Output voltage is 50 mV/div (±5%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.
+Gate — Positive-going rectangular waveform user selectable from A or B horizontal. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Output R is ≈950 Ω.
Sig Out — Selected by B Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V into 1 MΩ. Bandwidth depends upon vertical plug-in. Output R is ≈950 Ω.
Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series camera.
Probe Power — Two rear-panel connectors provide correct operating voltages for two active probes.
Single-Sweep Ready Indicators A and B — +5 V, rear panel BNC outputs for single sweep ready indications.
Graticule/Readout, Single-Shot — Ground closure, rear panel BNC input initiates one frame of CRT read-out and the Grat Illum is illuminated for ≈0.5 s.
External Single-Sweep Reset — Ground closure, rear panel BNC, provides input to reset sweep.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V to 132 V ac and 180 V to 250 V ac.
Line Frequency — 48 Hz to 440 Hz.
Maximum Power Consumption — 215 W, 3.3 A at 90 V line, 60 Hz.
Dimensions and Weights — See page 240.
For Recommended Cameras — See page 242.
For Recommended Plug-ins — See page 240.
Included Accessory — Instruction manual.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

7104 Oscilloscope **$21,380**
Option 02 — X-Y Horizontal Comp ..... +$300
Option 03 — EMC Modification ..... +$300

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

Plug-in Compatibility

7A29 — Vertical amplifier to bandwidth of mainframe; 10 mV/div to 1 V/div vertical sensitivity.
7A42 — Four channel, 350 MHz bandwidth vertical amplifier with Boolean logic triggering capabilities.
7B10 — Delayed time base (similar to 7B80) with 200 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 1 GHz.
7B15 — Delaying time base (similar to 7B85) with 200 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 1 GHz; capable of Δtime measurements in conjunction with 7B10.
The 7D01, 7D02 Logic Analyzers and 7D20 Digitizer are not recommended for use with the 7104 Mainframe. Such use will void the 7104 warranty.

NEW

NEW 7904A/R7903

500 MHz at 10 mV/div

700 ps Risetime (7904A)

500 ps/div Fastest Calibrated Sweep Rate

Greater Than 2.5 cm/ns Writing Speed

CRT Readout

Over 30 Compatible Plug-ins

900 MHz FET Probe Available

APPLICATIONS

* **Digital Design**
* **Radar**
* **Laser Research**

The 7904A and 5.25 inch rackmount R7903 are high bandwidth, general-purpose oscilloscopes. The 7A29 Amplifier/7904A Mainframe attains 500 MHz at 10 mV/div. A 7A29 variable delay option allows for the matching of signal transit times of two plug-ins and their probes to better than 50 ps.

The P6201 1X FET probe gives you high impedance and wide bandwidth. It has a 900 MHz bandwidth by itself, and in combination with the 7A29/7904A, it provides a system bandwidth of 450 MHz at 10 mV.

The CRT, the major contributor to the performance of the 7904A and R7903, has good visual brightness and an 8 cm x 10 cm display area.

CHARACTERISTICS

VERTICAL SYSTEM (7904A and R7903)

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit.

Modes of Operation — Left, Alt, Add, Chop, Right.

Chopped Mode — Rep rate is ≈1 MHz.

Trace Separation Range (Dual-Sweep Modes) — The B trace can be positioned four divisions above or below the A trace (7904A only).

Delay Line — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series time bases. 7B50 Series not recommended.

HORIZONTAL SYSTEM (7904A)

Channels — Two right-hand plug-in compartments; compatible with time bases of the 7B80 and 7B90 Series. 7000 Series vertical amplifiers and specialized plug-ins may also be used.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B92A.

Chopped Mode — Rep rate is ≈200 kHz.

X-Y Mode — Phase shift is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, Option 02) between vertical and horizontal channels. Bandwidth is dc to at least 1 MHz.

HORIZONTAL SYSTEM (R7903)

Single Channel — Right-hand plug-in compartment compatible with time bases of 7B80 and 7B90 Series. 7000 Series vertical amplifiers and specialized plug-ins may also be used.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B92A.

CRT AND DISPLAY FEATURES (7904A and R7903)

Standard — Internal 8 cm x 10 cm graticule with variable illumination. Accelerating potential is 24 kV with GH (P31) Phosphor standard.

Option 01 — No CRT readout (R7903 Only).

Option 04, Maximum Brightness CRT with Reduced Area — Internal 4 cm x 5 cm graticule with variable illumination. Accelerating potential is 24 kV with GH (P31) Phosphor standard.

Option 10, Pulsed Graticule (R7903 Only) — Provides a means of pulsing the graticule lights at a preset level coincident with a single-shot event in one exposure. The graticule lights may be pulsed by the event, an external ground closure, or a front panel pushbutton. If the mainframe is equipped with CRT readout, Option 10 provides additional controls and inputs for CRT readout pulsed operation.

Option 13, Maximum Brightness CRT with Reduced Area — Internal 4 cm x 5 cm graticule with variable illumination. Accelerating potential is 24 kV with BE (P11) phosphor.

Option 78, BE (P11) Phosphor.

NEW

The R7903 requires only 5.25 inches of rack height in a standard 19 inch rack. It is fan-cooled and comes complete with slide-out chassis tracks.

TYPICAL PHOTOGRAPHIC WRITING SPEED*1

CRT	Camera	Lens	Writing Speed cm/ns
Standard 8 cm x 10 cm	C-51P	f/1.2 1:0.5	2.5
Option 04 4 cm x 5 cm			4

**1 Using The Optional BE (P11) Phosphor and Polaroid Type 612 20,000 ASA Film without Film Fogging.*

In typical applications, GH (P31) Phosphor standard has ≈ one-half the writing speed of BE (P11) Phosphor. The writing speed can be increased by using controlled film fogging with a writing speed enhancer (camera accessory).

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

External Z-Axis Input — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

CALIBRATOR (7904A)

Output Waveshape — Rectangular positive-going from ground, 1 kHz (±0.25%).

Voltage Ranges — 40 mV, 0.4 V, 4 V into an open circuit. 4 mV, 40 mV, 0.4 V into 50 Ω.

Current Output — 40 mA.

CALIBRATOR (R7903)
(NOT AVAILABLE WITH OPTION 10)

Output Waveshape — Rectangular positive-going from ground, 1 kHz (±0.25%).

Voltage Ranges — 4 mV, 40 mV, 0.4 V, 4 V into an open circuit; 4 mV, 40 mV, 0.4 V into 50 Ω.

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

OUTPUTS/INPUTS (7904A)

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Front-panel selectable from A or B horizontal. Output voltage is 50 mV/div (±5%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

+GATE — Positive-going rectangular waveform derived from A, B, or Delayed Gate, front-panel selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 5 ns or less into 50 Ω.

Sig Out — Selected by B Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Bandwidth depends upon vertical plug-in. See the Vertical System Specifications Chart on page 241. Output R is ≈950 Ω.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series cameras.

Probe Power — Two rear-panel connectors provide correct operating voltages for two active probes.

OUTPUTS/INPUTS (R7903)
(STANDARD)

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

+Gate — Positive-going rectangular waveform derived from Main or Auxiliary Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Risetime is 7 ns or less into 50 Ω. Output R is ≈950 Ω.

Sig Out — Selected by Trigger Source switches. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Bandwidth depends on the vertical plug-in. See the Vertical System Specifications Chart on page 241. Output R is ≈950 Ω.

Single-Sweep Ready Output — +5 V, rear panel BNC output, for single-sweep ready indication.

External Single-Sweep Reset — Ground closure, rear panel BNC, provides input to reset sweep.

CRT Readout — Inhibit: Ground closure, rear panel BNC input locks out CRT readout. Not available with Option 10. Single-Shot: Ground closure, rear panel BNC input initiates one frame of CRT readout. Not available with Option 10 separately, but in combination with the pulsed graticule input.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series cameras.

Probe Power — Two front-panel connectors provide correct operating voltages for two active probes. Not available for R7903 Option 10.

OUTPUTS/INPUTS OPTIONS (R7903)

Option 10, Pulsed Graticule — No CRT readout single-shot input, CRT readout inhibit input, calibrator, and probe power. Single-shot graticule and CRT readout (ground closure) rear-panel BNC input is added. Initiates one frame of CRT readout and pulses graticule. CRT readout inputs are not functional with Option 01.

POWER REQUIREMENTS (7904A)

Line Voltage Ranges — 90 V to 132 V ac and 180 V to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 210 W, 3.5 A at 90 V line, 60 Hz.

POWER REQUIREMENTS (R7903)

Line Voltage Ranges — 90 V to 132 V ac and 180 V to 264 V ac.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 160 W, 2 A at 115 V line, 60 Hz.

INCLUDED ACCESSORIES (7904A)

Test adaptor (012-0092-00); nine-pin cable-mount plug (134-0049-00); two 18 in test leads (012-0087-00), instruction manual.

INCLUDED ACCESSORIES (R7903)

Test adaptor (012-0092-00); two 18 in test leads (012-0087-00); rack-mounting hardware, instruction manual.

Dimensions and Weights — See page 240.

For Recommended Cameras — See page 242.

For Recommended Plug-ins — See page 240.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)
(7904A AND R7903)

7904A Oscilloscope **$8,810**
R7903 Oscilloscope **$8,515**

Option 03 — EMC Modification ..... **+$300**

Option 04 — Maximum Brightness 4 cm x 5 cm CRT Display with GH (P31) Phosphor Standard ..... **+$500**

Option 13 — Maximum Brightness 4 cm x 5 cm CRT Display with BE (P11) Phosphor ..... **+$600**

Option 78 — BE (P11) Phosphor ..... **+$100**

OPTIONS (7904A)

Option 02 — X-Y Horizontal Comp ..... **+$250**

OPTIONS (R7903)

Option 01 — Without CRT Readout ..... **−$300**

Option 10 — Pulsed Graticule ..... **+$250**

CONVERSION KITS (7904A)

CRT Readout — Order 040-0605-03 ..... **$780**

X-Y Horizontal Comp — Order 040-0606-00 ..... **$325**

EMC Modification — Order 040-0570-00 ..... **$600**

CONVERSION KITS (R7903)

CRT Readout — Order 040-0605-03 ..... **$780**

EMC Modification — Order 040-0647-00 ..... **$315**

INTERNATIONAL POWER CORD AND PLUG OPTIONS
(7904A AND R7903)

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

Tektronix offers service training classes on the 7904A General Purpose Oscilloscope. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.

7704A/R7704

Dc to 200 MHz with Optimum Pulse Response

1.8 ns Risetime

Dc to 250 MHz Bandwidth Option

Greater Than 15 cm/ns Enhanced Writing Speed with Optional CRT and WSEN

CRT Readout

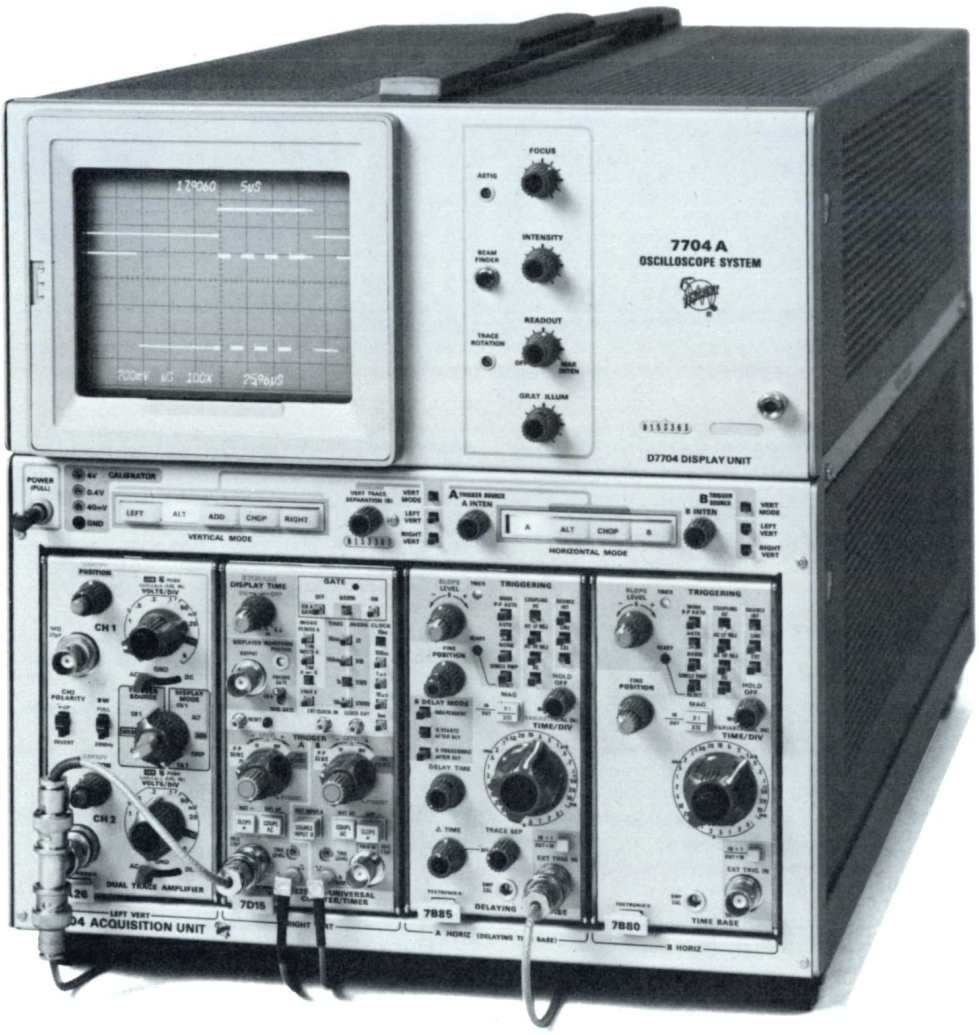
APPLICATIONS

- **Communications**
- **Digital Design**
- **Component Testing**

The 7704 Family is a wide bandwidth general-purpose oscilloscope measurement system.

The 7704A Oscilloscope offers you the capability to optimize the oscilloscope's response for your type of work. For pulse analysis, aberrations are reduced below the normal level in the optimized transient response version while still giving you a bandwidth of 200 MHz. The 250 MHz option is optimized for bandwidth performance for high-frequency applications. The R7704 offers a 175 MHz bandwidth.

Quite often the need arises to photograph the waveforms that are produced. The 7704A gives you a choice of two designs available for this purpose: the standard 8 cm x 10 cm CRT and an optional 4 cm x 5 cm reduced-scan CRT for high writing-speed applications. For additional information on the Writing Speed Enhancer (WSEN) see page 423, for a comparison of the 7000 Series writing rate specifications see page 230.



CHARACTERISTICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit. See Vertical System Specifications Chart on page 241.

Option 09, Bandwidth Change (250 MHz) — 7704A vertical circuit performance is adjusted to extend frequency response to 250 MHz at 20 mV/div (upper −3 dB) when 7A29 is used. Provides additional performance for those working in this frequency domain.

Modes of Operation — Left, Alt, Add, Chop Right.

Chopped Mode — 7704A, rep rate is internally selectable, ≈100 kHz or 1 MHz; R7704, fixed at ≈1MHz.

Trace Separation Range (Dual-Sweep Modes) — The B trace can be positioned above or below the A trace.

Delay Line — Permits viewing leading edge of waveform.

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments; compatible with all 7000 Series plug-ins.

Fastest Calibrated Sweep Rate — 2 ns/div with 7B80 or 7B90 Series.

Chopped Mode (Between Horizontal Plug-ins) — 7704A, rep rate is internally selectable, ≈20 kHz or 200 kHz; R7704, fixed at ≈200 kHz.

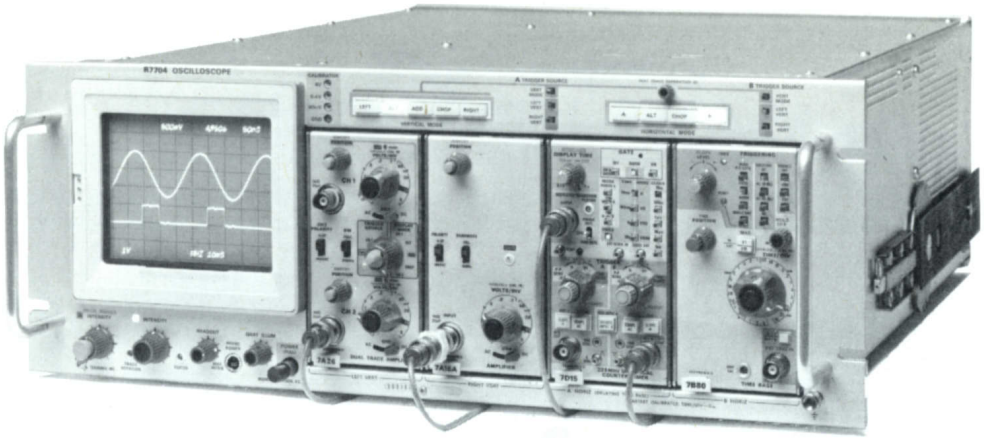
X-Y Mode — Phase shift is within 2° from dc to 50 kHz (7704A), from dc to 35 kHz (R7704) between vertical and horizontal channels. Frequency response at 10% down is dc to at least 3 MHz.

Option 02, X-Y Horizontal Compensation (R7704 Only) — Provides phase shift compensation to <2° from dc to 2 MHz.

CRT

Standard — Internal 8 cm x 10 cm graticule with variable illumination. Accelerating potential is 24 kV with GH (P31) Phosphor standard.

Option 01 — No CRT readout.



The R7704 requires 7 inches of rack height and offers 175 MHz bandwidth.

Option 04, Maximum Brightness CRT with Reduced Area (7704A Only) — Internal 4 cm x 5 cm graticule with variable illumination. Accelerating potential is 24 kV with GH (P31) Phosphor standard.

Option 13, Maximum Brightness CRT with Reduced Area (7704A Only) — Internal 4 cm x 5 cm graticule with variable illuminance. Accelerating potential is 24 kV with BE (P11) phosphor.

Option 78, BE (P11) Phosphor.

Photographic Writing Speed — Can be increased by using the Tektronix Writing Speed Enhancer. In typical applications, GH (P31) Phosphor standard has ≈ one-half the writing speed of BE (P11) Phosphor. GH (P31) Phosphor standard writing speed is >2.5 ns (cm).

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

External Z-Axis Input (7704A Only) — 2 V p-p for full intensity range, A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc-coupled.

External Z-Axis Input (R7704 Only) — Maximum pulse width to blank trace is 30 ns at 2 V; 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace; input R is 500 Ω within 10%. Maximum input voltage is 15 V (dc + peak ac) and p-p ac.

High Speed Input — Minimum pulse width to blank trace is 3.5 ns at 60 V; 60 V p-p for full intensity range from dc to 100 MHz. A positive signal blanks the trace; input R is 18 kΩ within 20%. Maximum input voltage is 60 V (dc + peak ac) and p-p ac.

OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω nominal.

+Gate — Positive-going rectangular waveform derived from A, B, or Delayed Gate, internally selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 20 ns or less into 50 Ω. Output R is 950 Ω nominal.

Sig Out — Selected by B Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. The bandwidth depends upon vertical plug-in. Output R is 950 Ω nominal.

External Single-Sweep Reset — Ground closure, rear-panel input to reset sweep.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

Probe Power — Two rear-panel connectors provide correct operating voltages for two active probes. R7704 connectors are located on both the front and rear panels. Probe power is deleted on Option 01 of 7704A.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (40 V and 4 mV available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Rep rate is 1 kHz within 0.25% (+15°C to +35°C); within 0.5% (0°C to +50°C).

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V to 132 V ac and 180 V to 264 V ac.

Line Frequency — 48 Hz to 440 Hz (7704A) 48 Hz to 66 Hz (R7704).

Option 05, Line Frequency Change (50 Hz to 400 Hz) — Converts the R7704 to 50 Hz to 400 Hz operation (not required for 7704A).

Maximum Power Consumption — 180 W, 2.5 A at 115 V line, 60 Hz (7704A); 225 W, 2.8 A at 115 V line, 60 Hz (R7704).

INCLUDED ACCESSORIES

For 7704A: 20 in two-pin-to-BNC cable (175-1178-00); instruction manual. For R7704: 42 in BNC 50 Ω cable (012-0057-01); rackmounting hardware; instruction manual.

Weights and Dimensions — See page 240.

For Recommended Cameras — see page 242.

For Recommended Plug-ins — See page 240.

ORDERING INFORMATION
(PLUG-INS NOT INCLUDED)

7704A Oscilloscope **$4,520**

R7704 Oscilloscope **$7,510**

OPTIONS (7704A)

Option 01 — Without CRT Readout and Probe Power ..... **−$300**

Option 03 — EMC Modification ..... **+$300**

Option 04 — Maximum Brightness 4 cm x 5 cm CRT Display with GH (P31) Phosphor Standard ..... **+$500**

Option 09 — Bandwidth Change (250 MHz) ..... **+$500**

Option 13 — Maximum Brightness 4 cm x 5 cm CRT Display with BE (P11) Phosphor ..... **+600**

Option 78 — BE (P11) Phosphor ..... **+$100**

OPTIONS (R7704)

Option 01 — Without CRT Readout ..... **−$300**

Option 02 — X-Y Horizontal Comp ..... **+$250**

Option 03 — EMC Modification ..... **+$300**

Option 05 — Line Frequency Change (50 Hz to 400 Hz) (not required for 7704A) ..... **+$300**

Option 78 — BE (P11) Phosphor ..... **+$100**

CONVERSION KITS (7704A)

CRT Readout and Probe Power — Order 040-0613-04 ..... **$480**

EMC Modification — Order 040-0612-00 ..... **$575**

Sig Out/In — Order 040-0619-02 ..... **$200**

CONVERSION KITS (R7704)

CRT Readout — Order 040-0533-01 ..... **$850**

X-Y Horizontal Comp — Order 040-0529-00 ..... **$300**

EMC Modification — Order 040-0562-00 ..... **$300**

INTERNATIONAL POWER CORD AND PLUG OPTIONS (7704A ONLY)

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Tektronix offers service training classes on the 7704A General Purpose Oscilloscope. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.

7603/R7603

Dc to 100 MHz Bandwidth

3.5 ns Risetime

6.5 Inch CRT

CRT Readout

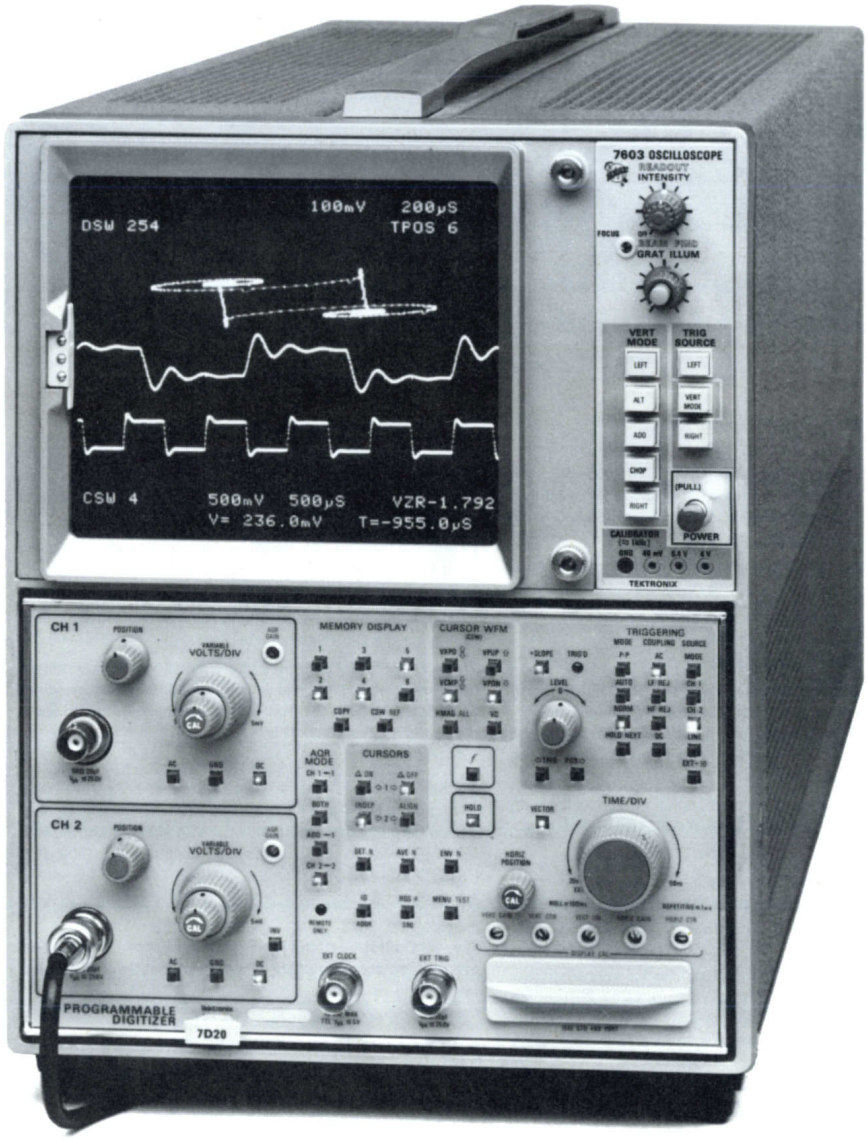
5.25 Inch Rackmount

APPLICATIONS

- **Digital Design and Testing**
- **Communications**
- **Spectrum Analysis**

The Tektronix 7603 and R7603 Oscilloscopes represent the best price/performance ratio available in the 100 MHz plug-in oscilloscope market today.

The CRT is large, 8 x 10 div (1.22 cm/div), and features an internal graticule with variable illumination and 15 kV accelerating potential. An optional maximum brightness CRT with a smaller 8 cm x 10 cm display and 18 kV potential gives you greater visual brightness and higher photographic writing speed. See page 230 for writing rate specifications.



CHARACTERISICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit. See Vertical System Specifications Chart on page 241.

Modes of Operation — Left, Alt, Add, Chop, Right.

Chopped Mode — Rep rate is ≈1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channels — One right-hand plug-in compartment; compatible with all 7000 Series plug-ins.

Fastest Calibrated Sweep Rate — 5 ns/div.

X-Y Mode — The phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.

CRT AND DISPLAY FEATURES

Standard — Internal 8 x 10 div (1.22 cm/div) graticule with variable illumination. Accelerating potential is 15 kV with GH (P31) Phosphor standard.

Option 01 — No CRT readout.

Option 04, Maximum Brightness CRT with Reduced Area — Internal 8 cm x 10 cm graticule with variable illumination. Accelerating potential is 18 kV with GH (P31) Phosphor standard.

Option 06, Spectrum Analyzer Graticule.

Option 13, Maximum Brightness CRT with Reduced Area — Internal 8 cm x 10 cm graticule with variable illumination. Accelerating potential is 18 kV with BE (P11) phosphor.

Optional Phosphors (Specify) — GM (P7), BE (P11), or GM (P7)/SA, (Phosphor/Spectrum Analyzer graticule combination.)

The R7603 requires only 5.25 inches of rack height in a standard 19 inch rack. It is fan cooled and comes complete with slide-out chassis tracks.

External Z-Axis Input — 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been adjusted.

Beam Finder — Limits display within graticule area.

OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output R is 950 Ω. Output voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω.

+Gate — Positive pulse of the same duration and coincident with sweep. Output R is 950 Ω. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Risetime is 20 ns or less into 50 Ω. Source is selectable from Main, Delay, or Auxiliary Gate.

Sig Out — Selected by Trigger Source switch. Output voltage is 0.5 V/div into 1 MΩ, 25 mV/div into 50 Ω. Output R is 950 Ω. Bandwidth depends upon vertical plug-in. See Vertical System Specifications Chart on page 241.

External Single-Sweep Reset — Ground closure, rear panel BNC provides input to reset sweep.

Single-Sweep Ready Output — Rear panel BNC provides 5 V for single-sweep ready condition.

CAMERA POWER OUTPUT

Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Rep rate is ≈1 kHz.

Current Output — 40 mA rectangular waveshape (dc current available when selected by internal jumper) with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.

Line Frequency — 50 Hz to 60 Hz (R7603 and 7603).

Option 05, Line Frequency Change (50 Hz to 400 Hz) — Converts the R7603 and 7603 to 50 Hz to 400 Hz operation.

Maximum Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Cooling is provided by a fan.

INCLUDED ACCESSORIES

For 7603 and R7603: a 20 in two-pin-to-BNC cable (175-1178-00); blue CRT filter (337-1700-01); clear CRT filter (337-1700-04); instruction manual. The R7603 includes rack-mounting hardware.

Dimensions and Weights — See page 240

For Recommended Cameras — See page 242.

For Recommended Plug-ins — See page 240.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

7603 Oscilloscope **$2,865**

R7603 Oscilloscope **$3,285**

OPTIONS (7603/R7603)

Option 01 — Without CRT Readout ..... **−$300**

Option 03 — EMC Modification ..... **+$300**

Option 04 — Maximum Brightness 8 cm x 10 cm CRT Display with GH (P31) Phosphor Standard. BE (P11) Optional ..... **+$500**

Option 05 — Line Frequency Change (50 Hz to 400 Hz) ..... **+$300**

Option 06 — With Internal Spectrum Analyzer Graticule ..... **+$50**

Option 13 — Maximum Brightness 8 cm x 10 cm CRT Display with BE (P11) Phosphor ..... **+$600**

OPTIONS (7603)

Option 08 — Protective Panel Cover ..... **+$100**

OPTIONS (R7603)

Option 20 — IEEE Standard 488 Interface for the 7D20 only ..... **+$250**

CONVERSION KITS (7603)

CRT Readout — Order 040-0654-02*1 ..... **$850**

EMC Modification — Order 040-1000-00 ..... **$290**

Power Supply — To Light Plug-in Pushbuttons. Order 040-0686-01 ..... **$60**

X-Y Horizontal Comp — Order 040-0718-00 ..... **$410**

CONVERSION KITS (R7603)

CRT Readout — Order 040-0674-02 ..... **$850**

EMC Modification — Order 040-0955-00 ..... **$125**

Power Supply — To Light Plug-in Pushbuttons. Order 040-0686-01 ..... **$60**

X-Y Horizontal Comp — Order 040-0718-00 ..... **$410**

PHOSPHOR OPTIONS (7603/R7603)

Option 76 — GM (P7) Phosphor ..... **+$100**

Option 77 — GM (P7) Phosphor with Internal Spectrum Analyzer Graticule ..... **+$100**

Option 78 — BE (P11) Phosphor ..... **+$100**

INTERNATIONAL POWER CORD AND PLUG OPTIONS (7603 and R7603)

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

OPTIONAL ACCESSORIES (R7603)

A field installable kit adds Option 20 to the standard R7603. Intended for use with a previously purchased R7603, this kit provides parts to connect the 7D20's IEEE Standard 488 Interface to the R7603 mainframe.
Order 040-1093-00 ..... **$375**

Five other field installable kits are available, one for each of the international power cord and plug options, A1-A5. Contact your local Tektronix Field Office for information.

A1 — Universal Euro. Order 040-1094-00*1

A2 — UK. Order 040-1095-00*1

A3 — Australian. Order 040-1096-00*1

A4 — North American. Order 040-1097-00*1

A5 — Switzerland. Order 040-1098-00*1

*1 *Not available for 7603N11S.*

7603N11S

Ruggedized for Extreme Environments

Meets or Exceeds MIL-O-24311 (EC) (AN/USM-218C Specifications)

Large, Bright Display—6.5 Inch CRT (15 kV)

5 ns/div Delaying Sweep

0.5 mV Vertical Sensitivity

Three-Plug-In Flexibility

Versatile Trigger-Source Selection

Pushbutton Switching

Illuminated No-Parallax Graticule

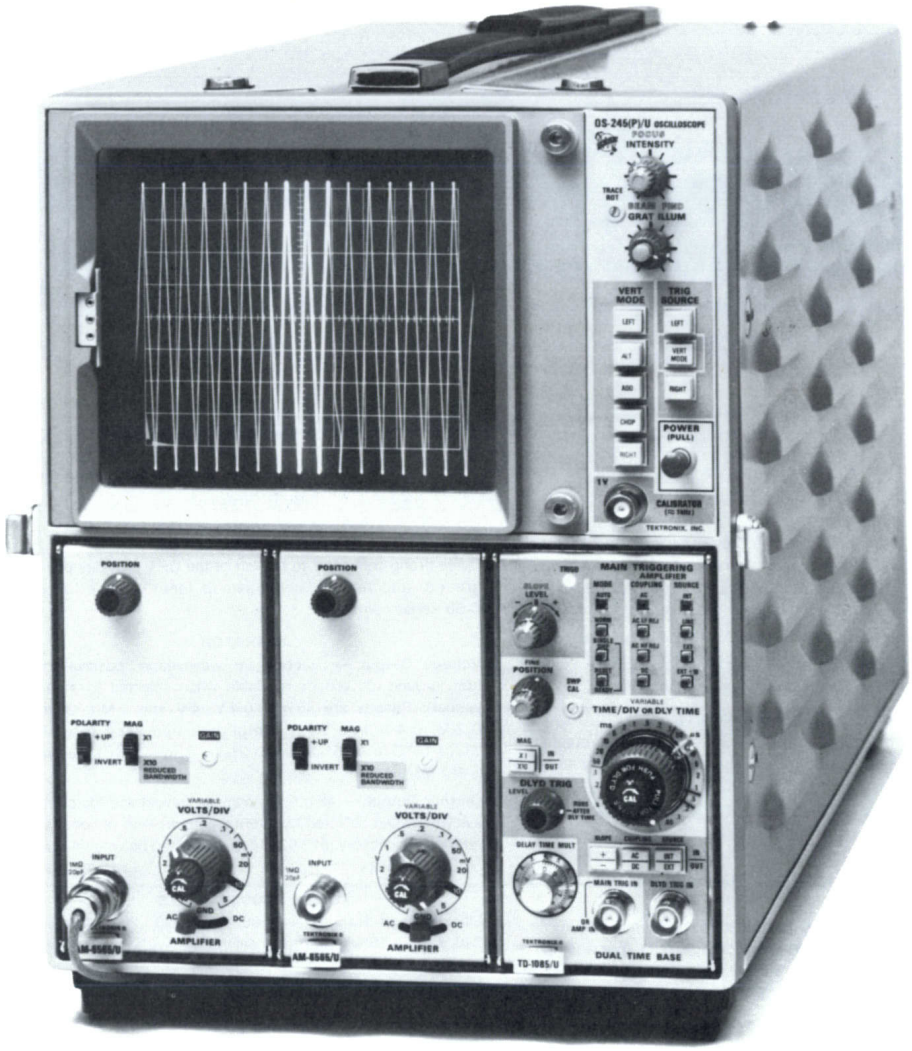
Color-Keyed Panels

Protective Cover with Accessories

The 7603N11S Ruggedized Oscilloscope System meets the rigid environmental and electrical specifications required by MIL-O-24311 (EC) and appears on U.S. Navy QPL-24311. The system consists of a three plug-in mainframe, two single-trace amplifiers, a dual time base, and a front-panel cover with probes and accessories.

Although the military spec requires only 50 MHz performance, this system actually performs to 65 MHz. Other better-than-required specs include operating altitude, sensitivity at reduced bandwidth with 10X gain, "X" sensitivity in X-Y mode, triggering frequency range, delaying and delayed sweep speeds, and CRT size.

The mainframe and plug-ins are compatible with the Tektronix 7000 Series product line. The system does not have CRT readout, and it can't be used with the digital plug-ins. See page 230 for photographic writing speed specifications.



CHARACTERISTICS

ENVIRONMENTAL

Temperature — Nonoperating: −62°C to +75°C. Operating: −28°C to +65°C.

Humidity — 0% to 95% RH over entire temperature range, operating or nonoperating.

Altitude — Nonoperating: Sea level to 15 000 m (50,000 ft). Operating: Sea level to 4500 m (15,000 ft).

Vibration (Operating) — 5 Hz to 15 Hz at 0.060 in ±0.012 in p-p amplitude, 16 Hz to 25 Hz at 0.040 in ±0.008 in p-p amplitude, 26 Hz to 33 Hz at 0.020 in ±0.004 in p-p amplitude.

Shock (Operating) — Nine consecutive 400 pound hammer blows without failure from 1, 3, and 5 ft in vertical, horizontal, and longitudinal axis as per MIL-S-901 for Grade A, Class 1, Type A for lightweight equipment.

Inclination (Operating) — As per MIL-E-16400.

Drip Proof (Nonoperating) — As per MIL-STD-198

Salt Spray (Nonoperating) — As per MIL-E-16400.

Electromagnetic Interference — As per MIL-STD-462 performed by MIL-STD-461 for the following tests:

CE-01	30 Hz to 20 kHz	Power lead emission
CE-03	20 kHz to 50 MHz	Power lead emission
CS-01	30 Hz to 50 kHz	Power lead, radiation susceptibility
CS-02	50 kHz to 400 MHz	Power lead, radiation susceptibility
CS-06	Spike Test	Power lead, spike susceptibility
RE-01	30 Hz to 30 kHz	Instrument radiation, magnetic
RE-02	14 kHz to 10 GHz	Instrument radiation, electric
RS-01	30 Hz to 30 kHz	Instrument susceptibility, magnetic
RS-03	14 kHz to 10 GHz	Instrument susceptibility, electric

Reliability — Optimum performance and reliable service are provided during continuous or interrupted operation. The MIL-O-24311(EC) MTBF requirement of >600 hours is met as tested under the following conditions: temperature +40°C ±2°C; relative humidity 70% ±5%; vibration 25 Hz at 0.040 in ±0.008 in p-p amplitude for 10 minutes of each "Power On" hour during each day of the 8 hour manned schedule; power cycled at 4 hour intervals with power off for 10 minutes each 4 hour period of the manned test schedule. An MTBF of >2000 hours was achieved during testing.

VERTICAL SYSTEM
(INCLUDES TWO 7A15AN11 PLUG-INS)

Channels — Two left-hand plug-in compartments, with a delay line which allows the leading edge of the displayed waveform to be viewed. All 7000 Series plug-ins are compatible (except those which require CRT readout).

Display Modes — Left, Alt, Add, Chop, Right. Chopped frequency is ≈1 MHz. Added mode displays signals algebraically with a CMRR of 20:1 to 25 MHz.

Bandwidth/Sensitivity — Dc to 65 MHz from 5 mV/div to 10 V/div, accuracy within 2%, variable extends to 25 V/div. Maximum sensitivity is 0.5 mV at 10 MHz with 10X gain. Ac coupling lower −3 dB point is <2 Hz. Risetime is 5.4 ns with <2% aberrations.

Input R and C — 1 MΩ within 2%, <27 pF.

Maximum Input Voltage — 400 V (dc + peak ac).

Dc Stability — <1 div/hr drift at 25°C.

HORIZONTAL SYSTEM
(INCLUDES ONE 7B53AN11 PLUG-IN)

Channels — One right-hand plug-in compartment. All 7000 Series plug-ins are compatible (except those which require CRT readout).

Internal Trigger Modes — Left Vert, Vert Mode, Right Vert.

X-Y Mode — The phase shift between vertical and horizonal channels is <2° from dc to 35 kHz. Bandwidth is at least 2 MHz. Risetime is <175 ns. Using the 7B53AN11 Time Base External Amplifier, 10 mV, 100 mV, and 1 V sensitivities (±10%) are available. Input R and C for 7B53AN11 is 1 MΩ within 2%, 20 pF within 2 pF. Any vertical plug-in, such as the 7A15AN11, may be used in the horizontal compartment, providing a greater number of sensitivities for calibrated X-Y displays.

Sweep Display Modes — Main Sweep, Main Sweep Intensified by Delayed Sweep, Delayed Sweep.

MAIN (DELAYING) SWEEP

Sweep Rate — 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div fastest calibrated sweep rate, obtained with X10 magnifier. The uncalibrated variable is continuous between steps and to 12.5 s/div.

Sweep Accuracy — Within 3% from 0.05 μs/div to 5 s/div, within 5% at 5 ns/div.

Sweep Modes — Normal, Auto, Single Sweep.

Delay Time — Multiplier range is 0 to 10 times the Time/Div setting. Accuracy is within 1% from 0.5 s/div to 0.5 μs/div, within 2% from 5 s/div to 1 s/div. Incremental linearity is within 0.2% of full scale. Jitter is <1 part in 20,000 of 10X time/div setting.

Triggering (Source/Sensitivity) — Internal 0.5 cm to 50 MHz. External, 0.25 V to 20 MHz, 0.5 V to 50 MHz. Ext ÷ 10, 2.5 V to 20 MHz, 5 V to 50 MHz. Triggering extends to 100 MHz with reduced sensitivity in both Internal and External Modes. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF.

Triggering Frequency Range — Ac, 30 Hz to 50 MHz; ac LF Rej. 30 kHz to 50 MHz; ac HF Rej. 30 Hz to 50 kHz; dc, dc to 50 MHz. With external level range, slope is ±30 V.

DELAYED SWEEP

Triggering (Source/Sensitivity) — Internal 0.3 div to 10 MHz increasing to 1.5 div at 50 MHz. External, 0.1 V to 10 MHz increasing to 0.5 V at 100 MHz. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF.

Triggering Frequency Range — Ac: 30 Hz to 50 MHz. Dc: 30 Hz to 50 MHz.

Sweep Rate — 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). The delayed sweep runs after delay time or is triggerable after delay time.

Sweep Accuracy — Within 3% from 50 ms/div to 0.5 μs/div, within 4% for all other sweep rates except the magnified X10 sweep rate of 5 ns/div, which is within 6%.

CRT

Accelerating Potential — 15 kV.

Phosphor — GH (P31) is standard.

Graticule — Internal 8 cm x 10 cm with variable illumination. The 6.5 in CRT permits 2 cm of linear overscan in both axes, making a total viewing area of ≈10 cm x 12 cm.

CRT Controls — Located on front panel are Focus, Intensity, Graticule Illumination, Beam Finder, and Trace Rotation. Astigmatism is an internal control.

External Z-Axis Input (BNC Connector on Rear Panel) — 2 V p-p for full intensity range from dc to 2 MHz, intensity range diminishes to 20% of full range at 10 MHz. Maximum input voltage is 10 V (dB + peak ac).

OUTPUTS

Calibrator (BNC Connector on Front Panel) — 1 V within 1%, 1 kHz squarewave within 20%.

Horizontal — Main Sweep +5 V, Delayed Sweep +5 V, Main Sweep Gate +2 V, Delayed Sweep Gate +2 V, Delayed Trigger +1 V with pulse width of >50 ns. All amplitudes are minimum and measured when working into at least 100 kΩ and 15 pF.

POWER REQUIREMENTS

Input Voltages — 100, 110, 120, 220, and 240 V ac ±10% internally selectable with quick-change jumpers with 47.5 to 440 Hz single phase line frequency. Maximum power consumption is 125 W.

C281 COVER WITH ACCESSORIES

The cover provides protection during transport and packages the included accessories.

INCLUDED ACCESSORIES
(ALL PACKAGED IN COVER)

Two P6006 Probe packages (010-0127-00); two 8 ft, 50 Ω BNC cables (012-0366-00); two BNC female to UHF male adaptors (103-0015-00); two BNC T connectors (103-0030-00); two BNC male to UHF female adaptors (103-0032-00); two BNC male to binding post adaptors (103-0033-00). One set of technical manuals (not packaged in cover).

Dimensions and Weights — See page 240.

For Recommended Cameras — See page 242.

ORDERING INFORMATION

7603N11S Oscilloscope System
(AN/USM-281C) 7603NMS **$8,040**

System Includes — A 7603N11 Oscilloscope, two each 7A15AN11 Amplifier Plug-ins, 7B53AN11 Time Base, and C281 Cover with Accessories.

To Order Separately:

7603N11 Oscilloscope*1
(OS-245(P)/U)
Order 7603N11 ..... **$3,950**

7A15AN11 Amplifier
Plug-in (AM-6565/U)
Order 7A15ANM **$850**

7B53AN11 Time Base
Plug-in (TD-1085/U)
Order 7B53ANM **$2,025**

C281 Cover W/Accessories
Order 016-0553-00 ..... **$320**

**1 CRT readout not available.*

7844/R7844

400 MHz Bandwidth

900 ps Risetime

Dual Beam

Full Vertical Crossover Switching

8 cm x 10 cm Display

CRT Readout

1 ns/div Maximum Calibrated Sweep

APPLICATIONS

* **Radar/Lidar**
* **Destructive Testing**
* **SCR Switching**

The 7844 and 7 inch rackmount R7844 are wide bandwidth, dual-beam oscilloscopes designed primarily for fast, single-shot events. Unique features such as pulsed graticule and pulsed CRT readout allow you to photograph vertical and horizontal scale factors, test date, test number, and other pertinent data before or after an event. Vertical signal crossover switching permits you to view a single event from a single probe at two sweep speeds. See page 230 for photographic writing speed specifications.

CHARACTERISTICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit.

Display Logic

	Beam 1	Beam 2
Vertical Compartment Controlling Beam	Left	Left
	Left	Right
	Right	Left
	Right	Right

Vertical Crossover — Permits viewing the same signal on two time bases.

Vertical Trace Separation — Beam 1 can be positioned ±4 cm with respect to Beam 2.

Delay Line — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series time bases; not compatible with 7B50 Series.

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments; compatible with time bases of the 7B80 and 7B90 Series. 7000 Series vertical amplifiers and specialized plug-ins may also be used. 7B53AN11 requires modification for use in the 7844.

Fastest Calibrated Sweep Rate — 1 ns/div.

X-Y Mode — Phase shift is within 2° from dc to 50 kHz.

Bandwidth — Dc to at least 1 MHz.

Horizontal Separation — Beam 1 can be positioned at least 0.25 cm to the right and at least 0.25 cm to the left of Beam 2 with a total 2 cm range.

Display Logic

Beam 1	Beam 2
A Horizontal	A Horizontal
A Horizontal	B Horizontal
B Horizontal	A Horizontal
B Horizontal	B Horizontal

CRT AND DISPLAY FEATURES

CRT — Dual beam, full overlap. 8 cm x 10 cm graticule with variable illumination. CRT readout intensity is adjustable with front-panel control. Accelerating potential is 24 kV with GH (P31) Phosphor standard.

Option 78 — BE (P11) Phosphor.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder (Beam 1 and Beam 2, Independent Controls) — Limits display within graticule area and intensifies beam.

External Z-Axis Input (Beam 1 and Beam 2) — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac), p-p ac and dc coupled.

Typical Photographic Writing Speed (Using Polaroid Type 612 20,000 ASA Film without Film Fogging) — In typical camera applications, GH (P31) Phosphor standard has about one-half the writing speed of BE (P11) Phosphor. Writing speed can be increased by using controlled film fogging with a writing speed enhancer.

The photographic writing speed enhancer, Option 22, provides a preset automatic method of film fogging for the 7844. Option 22 is recommended for writing speed enhancement when a camera with a writing speed enhancer is not available.

Pulsed Readout and Graticule Illumination — Provides a means of pulsing the graticule lights and CRT readout at a preset level, coincident with a single-shot event in one exposure. The graticule lights and CRT readout can be pulsed by the event, an external ground closure, or front-panel pushbutton.

CALIBRATOR

Calibrator — Rectangular positive-going waveform from ground, 1 kHz (±0.25%).

Voltage Ranges — 4 mV, 40 mV, 0.4 V, 4 V (±1%) into an open circuit; 0.4 mV, 4 mV, 40 mV, 0.4 V (±1%) into 50 Ω.

Current Output — 40 mA (±1%) rectangular waveshape, front panel current loop 7844, optional current loop adaptor (012-0341-00) required for R7844.

OUTPUTS/INPUTS

A and B + Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

A and B + Gate — Positive-going rectangular waveform derived from Main or Delayed Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Risetime is 5 ns or less into 50 Ω. Output R is ≈950 Ω.

Single-Sweep Ready Output — +5 V, rear panel BNC output, for single-sweep ready indication.

External Single-Sweep Reset — Ground closure, rear panel BNC, provides input to reset sweeps.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series cameras.

Probe Power — Two connectors provide correct operating voltages for two active probes.

POWER REQUIREMENTS

Line Voltage Ranges — Selectable 115 V nominal (90 V to 132 V), 230 V nominal (180 V to 264 V).

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 235 W, 2.9 A at 60 Hz 115 V line.

INCLUDED ACCESSORIES (R7844)

Rackmount hardware kit and slide guide (351-0314-01); instruction manual.

Dimensions and Weights — See page 240.

For Recommended Cameras — See page 242.

For Recommended Plug-ins — See pages 240.

ORDERING INFORMATION

PLUG-INS NOT INCLUDED)

7844 Oscilloscope **$13,435**

R7844 Oscilloscope **$13,845**

Option 03 — EMC Modification ..... **+$300**

Option 22 — Writing Speed Enhancer ..... **+$400**

Option 78 — BE (P11) Phosphor ..... **+$100**

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

7000 SERIES CRT STORAGE MAINFRAMES

Storage mainframes in the 7000 Series offer a full selection of stored writing speeds: from ≈0.03 cm/μs for mechanical, spectrum analysis, or TDR applications, to 2500 cm/μs for capturing fast single events such as high speed digital logic. A selection of storage modes offers the following features:

Bistable ..... Long View Time

Variable Persistence ..... High Contrast Displays

FAST Bistable ... Captures Fast Single or Multiple Events

FAST Variable Persistence ..... Provides Maximum Stored Writing Rate

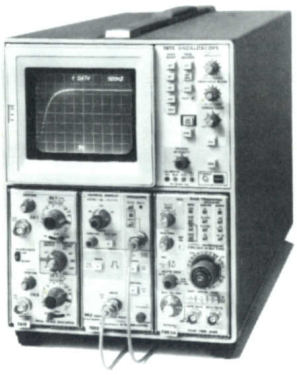
CONTENTS

Nonstorage Mainframes 243

CRT Storage Mainframes 255

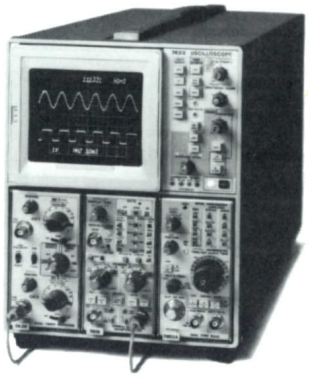
Plug-Ins 262

High Performance Digitizing Mainframes 336

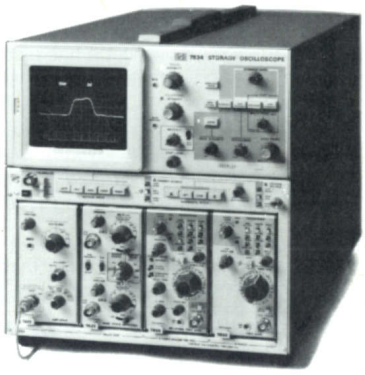


7613
Variable
Persistence

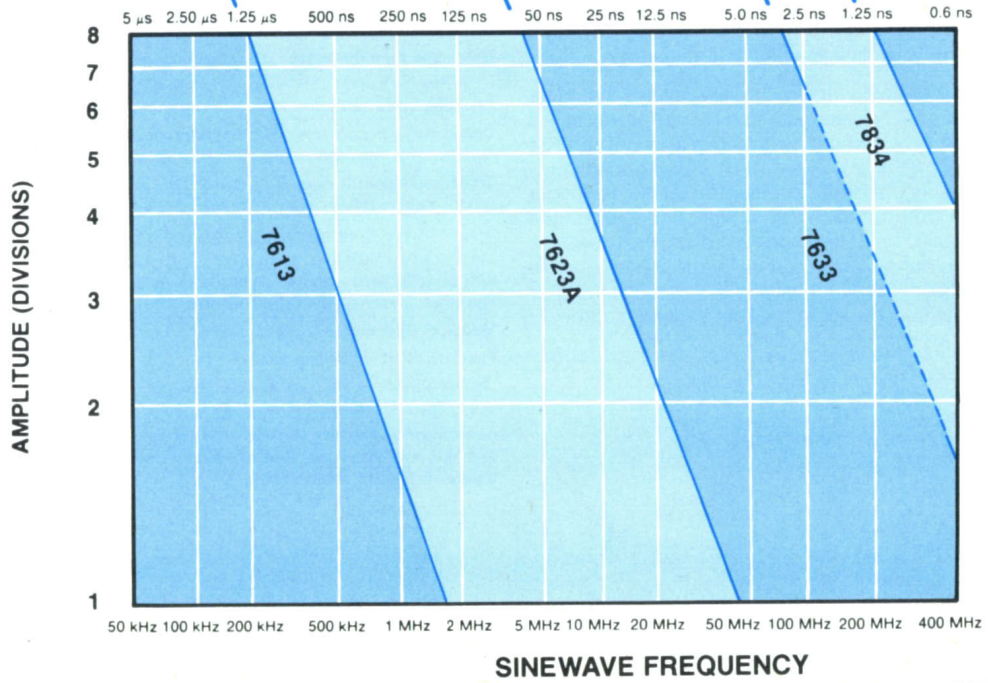
7623A
FAST
Multimode



7633
FAST
Multimode



7834
FAST
Multimode



Graph shows the stored writing speed needed to display a given sinewave or step risetime at a given amplitude.

7834

2500 cm/μs Stored Writing Speed

Stores Single-Shot Risetimes as Fast as 1.4 ns

Dc to 400 MHz Bandwidth

Multimode Storage

Long View Time

APPLICATIONS

- **Laser Fusion**
- **Digital Design**
- **Radar/Lidar**

The 7834 Storage Oscilloscope has a stored writing speed of 2500 cm/μs, enabling storage of single-shot risetimes to 1.4 ns, 3.6 cm high, at eight-divisions amplitude, reduced-scan mode. The 7834's mainframe bandwidth is 400 MHz. The system bandwidth may vary from 160 MHz to 400 MHz depending on the plug-in selected.

This instrument has four storage modes: Bistable, Variable Persistence, Fast Bistable and Fast Variable Persistence.

Bistable provides stored displays with long (30 minute) view time.

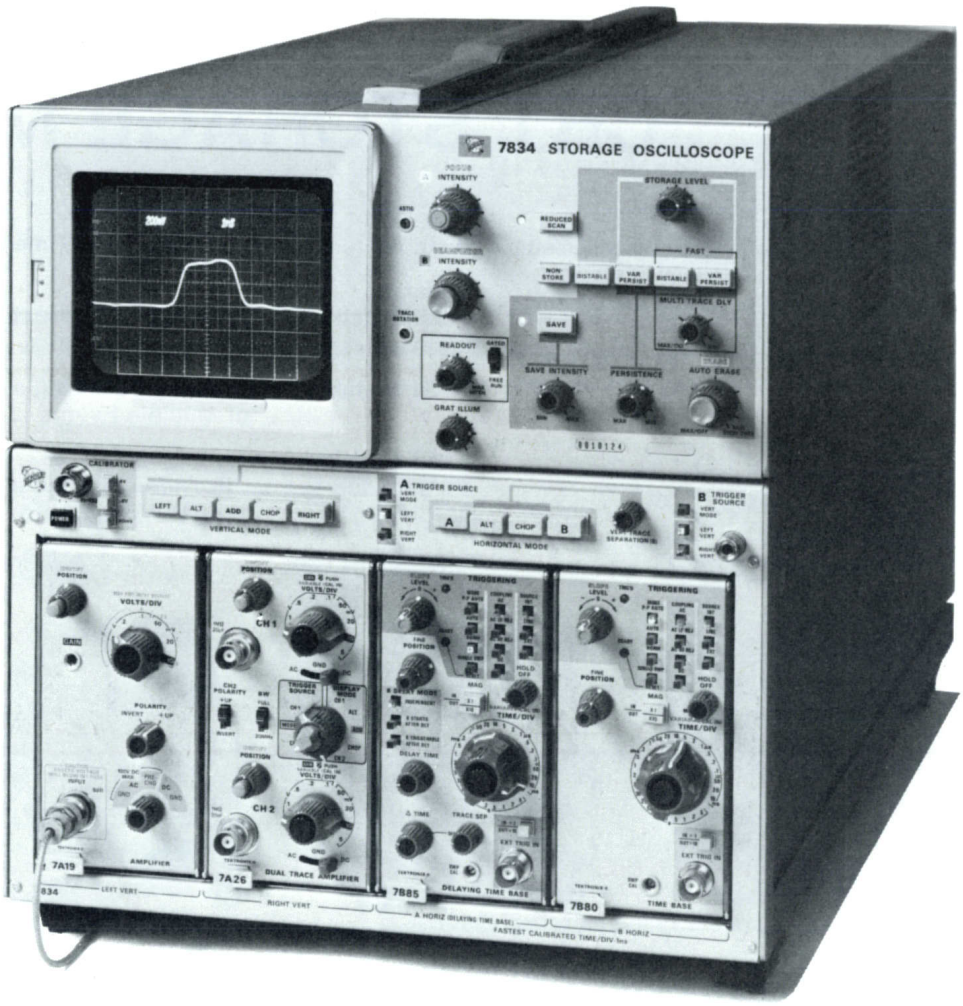
Variable Persistence gives high contrast displays of both single-shot and repetitive phenomena. When viewing changing waveshapes, variable persistence provides continuous bright displays of new information as old information fades from the CRT.

Fast Bistable increases bistable writing rates to 350 cm/μs (reduced scan).

Fast Variable Persistence provides the maximum stored writing rate of 2500 cm/μs (reduced scan). View time is at least 30 seconds.

The four-compartment flexibility means that more than one measurement can be performed at the same time without switching plug-ins. The 7834 also offers auto-erase for automatic display updating...a save control for 30 times longer viewing...gated readout which prevents the blooming that tends to occur between sweeps with nongated readout...and an adjustable multitrace delay for varying the viewing time prior to the next sweep in the Fast transfer mode.

The multimode storage unit is designed for single shot, low-rep-rate or fast pulse analysis.



CHARACTERISTICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins.

Modes of Operation — Left, Alt, Add, Chop, Right.

Mainframe Bandwidth — 400 MHz with 7A29 Amplifier plug-in.

Mainframe Step Response — 900 ps or less with 7A29 Amplifier plug-in.

Chopped Mode — Rep rate is ≈1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform (not recommended for use with 7B50 Series time bases).

Trace Separation Range — In dual-sweep modes, B trace can be positioned four divisions above or below the A trace.

HORIZONTAL SYSTEM

Input — Two right-hand plug-in compartments; compatible with all 7000 Series plug-ins. 7000 Series vertical amplifiers and specialized plug-ins may also be used.

Modes of Operation — A, Alt, Chop, B.

Fastest Calibrated Sweep Rate — 1 ns/div.

Chopped Mode — Rep rate is ≈200 kHz.

X-Y Mode — Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, B horizontal only, Option 02). Bandwidth is dc to at least 1 MHz.

CRT AND DISPLAY FEATURES

Graticule — Internal variable illuminated graticule. 8 x 10 div (0.9 cm/div) gratule in full scan and 8 x 10 div (0.45 cm/div) in reduced scan.

Option 01 — Deletes CRT readout and probe power.

Accelerating Potential — ≈10 kV full scan mode, and 12 kV in reduced scan mode.

Phosphor — GH (P31) is standard.

CRT Display Modes — Nonstore, Bistable, Variable Persistence, Fast Bistable and Fast Variable Persistence (full and reduced scan).

Persistence — (Variable Persistence mode only) controls rate of continuous erasure of the variable persistence and fast variable persistence stored displays.

Auto Erase — Continuously variable from <1 s to >10 s.

Multitrace Delay — Adjusts the transfer cycle time in the Fast transfer modes. Continuously variable from <1 s to >4 s.

Save — Prevents display from being accidentally erased, and provides up to 30 times longer viewing times in all modes.

External Z-Axis Input — 2 V p-p for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

Auto-Focus — Maintains CRT focus following changes in display intensity after focus control has been initially set.

Beam Finder — Limits display within graticule.

STORAGE WRITING SPEED

FULL SCAN (Center 6 x 8 div at 0.9 cm/div)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	270 cm/μs (300 div/μs)	45 cm/μs (50 div/μs)	1.8 cm/μs (2 div/μs)	0.03 cm/μs (.03 div/μs)
View Time	30 s*1	30 min*2	30 s*1	30 min
≈Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

REDUCED SCAN (Center 8 x 10 div at 0.45 cm/div)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	2500 cm/μs (5,500 div/μs)	350 cm/μs (776 div/μs)	5.4 cm/μs (12 div/μs)	0.09 cm/μs (0.2 div/μs)
View Time	30 s*1	30 min*2	30 s*1	30 min*1
≈Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

**1 View times are at full stored display intensity. They may be increased more than 30 times by using reduced intensity in the Save display mode.*

**2 Save intensity at minimum.*

Fast Variable Persistence Writing Speed

Scan Mode	Sweep Speed	Peak-to-Peak Sinewave	Step Response
Reduced Scan 5,500 div/μs (0.45 cm/div)	⩾1 ns/div	7.1 div 250 MHz	7.7 div 1.4 ns
		8 div 221 MHz	8 div 1.45 ns
Full Scan 300 div/μs (0.9 cm/div)	⩾10 ns/div	3.2 div 30 MHz	3 div 10 ns
		6.4 div 15 MHz	5 div 16.6 ns

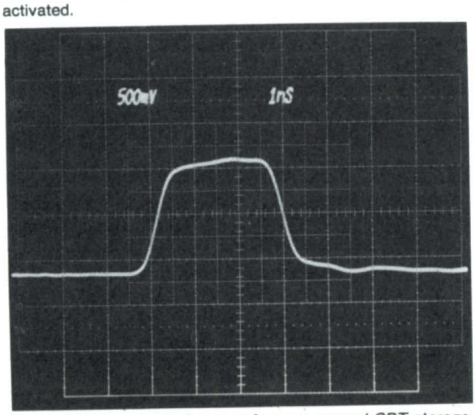
OUTPUTS/INPUTS

+Sawtooth — Positive going with baseline at 0 V ±1 V into 1 MΩ. Voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is ≈950 Ω.

+Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Output R is ≈950 Ω. Source is selectable from A Gate, B Gate or A Delayed Gate.

Vertical Signal Out — Selected by A Trigger Source switch. Output voltage is 0.5 V into 1 MΩ, 25 mV into 50 Ω. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in.

Remote Single Sweep Reset, Remote Save and Remote Erase — Rear panel BNC connector inputs, ground closure activated.



Readout is stored with the waveform on several CRT storage scopes including the 7613, 7623A, 7633 and 7834 (shown). Multimode storage is available on the 7623A, 7633, and 7834.

Remote Fast Transfer Gate — TTL compatible. Low to high transition enables high speed target to receive information to be stored; high to low transition initiates transfer from high speed target to storage target.

Camera Power Output — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

Probe Power — Two rear-panel connectors provide operating voltages for two active probes such as P6201.

CALIBRATOR

Voltage Output — Squarewave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; rep rate is 1 kHz within 0.25%.

Current Output — 40 mA available through Calibrator output with optional BNC to current loop adaptor.

Dimensions and Weight — See page 240.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V to 132 V ac and 180 V to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 215 W.

INCLUDED ACCESSORIES

Installed gray CRT filter (378-0625-02); green CRT filter (378-0625-08); power cord (161-0066-00); instruction manual.

For Recommended Cameras — See page 242.

For Recommended Plug-ins — See page 240.

For Recommended Probes — See page 240.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

7834 Storage Oscilloscope **$12,415**

OPTIONS

Option 01 — Without CRT Readout and Probe Power ..... **−$300**

Option 02 — X-Y Mode Phase Correction ..... **+$250**

Option 03 — EMC Modification ..... **+$300**

Cradle Mount Adaptor — For Rackmounting. Order 040-0560-00 ..... **$445**

CONVERSION KITS

CRT Readout — Order 040-0811-03 ..... **$480**

EMC Modification — Order 040-0880-00 ..... **$625**

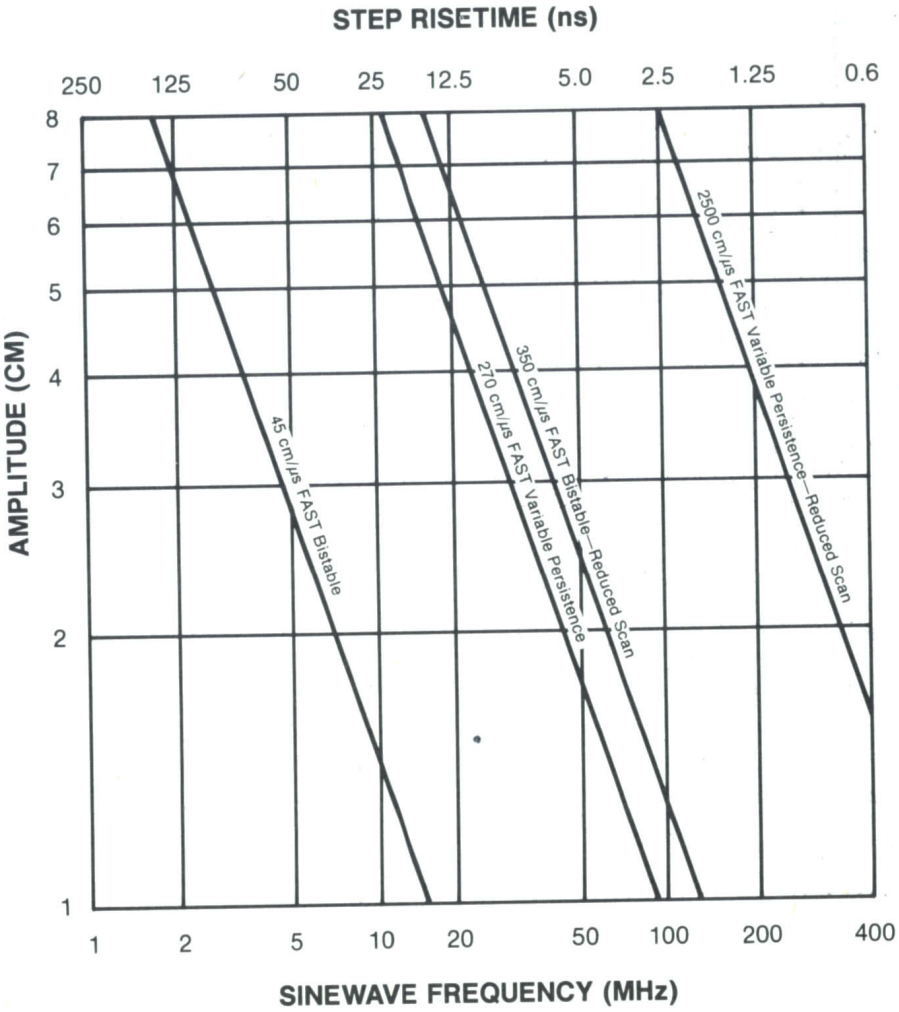
INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz



Graph showing the stored writing speed needed to display a given sinewave or step risetime at a given amplitude.

7633/R7633 & 7623A/R7623A

1000 cm/μs Stored Writing Speed (7633/R7633)

135 cm/μs Stored Writing Speed (7623A/R7623A)

Long View Time

Multimode Storage

Dc to 100 MHz Bandwidth

APPLICATIONS (7633/R7633)

* **Digital Design**
* **Destructive Test**
* **Communications**

APPLICATIONS (7623A/R7623A)

* **Ultrasonics**
* **Power Supply Design**
* **Component Testing**

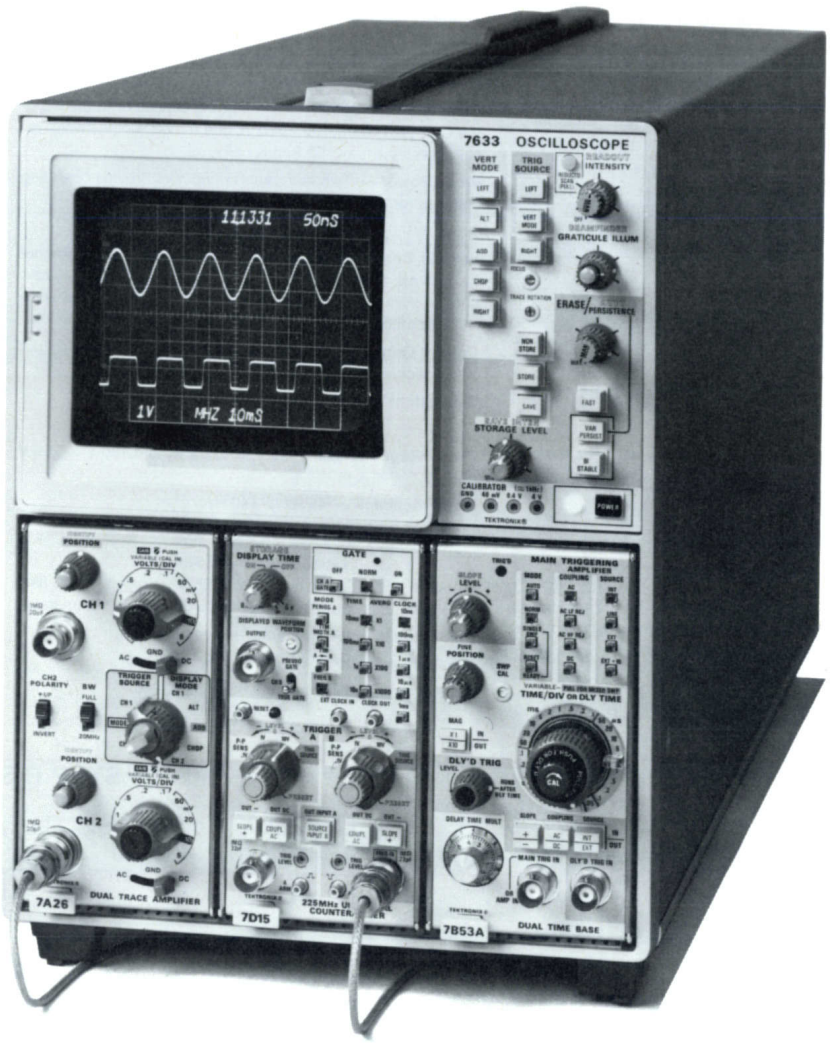
The Tektronix 7633 Storage Oscilloscope provides 2200 div/μs (1000 cm/μs) stored writing speed and 100 MHz bandwidth. The instrument has three display modes—store, nonstore, and save—and four storage modes—bistable, variable persistence, fast bistable, and fast variable persistence. The maximum writing speed of 1000 cm/μs (using the center 8 x 10 reduced scan divisions, 0.45 cm/div) is achieved in reduced scan mode.

This multimode storage instrument allows for retention and viewing for fast-rise, low-repetition-rate, single-shot, or slow-moving waveforms.

The R7633 and R7623A require only 5.25 inches of rack height in a standard 19 inch rack. They are fan cooled and come complete with slide-out chassis tracks.

Characteristics are common to the 7633/R7633 and the 7623A/R7623A unless noted.

The Tektronix 7623A and R7623A Storage Oscilloscope have all the features and performance of the 7633/R7633 except the reduced scan mode.



CHARACTERISTICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit.

Modes of Operation — Left, Alt, Add, Chop, Right.

Chopped Mode — Rep rate is ≈1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channel — One right-hand plug-in compartment; compatible with all 7000 Series plug-ins.

Fastest Calibrated Sweep Rate — 5 ns/div.

X-Y Mode — The phase shift between vertical and horizontal channels is <2° from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (0.9 cm/div) and 8 x 10 div (0.45 cm/div) graticule with variable illumination.

Phosphor — GH (P31) is standard.

Option 01 — No CRT readout.

Accelerating Potential — ≈8.5 kV in normal mode, 10 kV in reduced scan mode.

Storage Display Modes — Nonstore, fast variable persistence, fast bistable, variable persistence, bistable. Full or reduced scan may be selected on the 7633 in all display modes. Select normal scan to view the entire CRT; select reduced scan for the fastest writing rate.

Persistence — Variable. When set to maximum, provides the longest retention of high contrast stored displays, without the characteristic fading of variable persistence.

Autoerase — Variable up to 10 seconds.

Save — Prevents erasing and storing additional displays; also extends view time in variable persistence mode.

External Z-Axis Input — 2 V p-p for useful intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

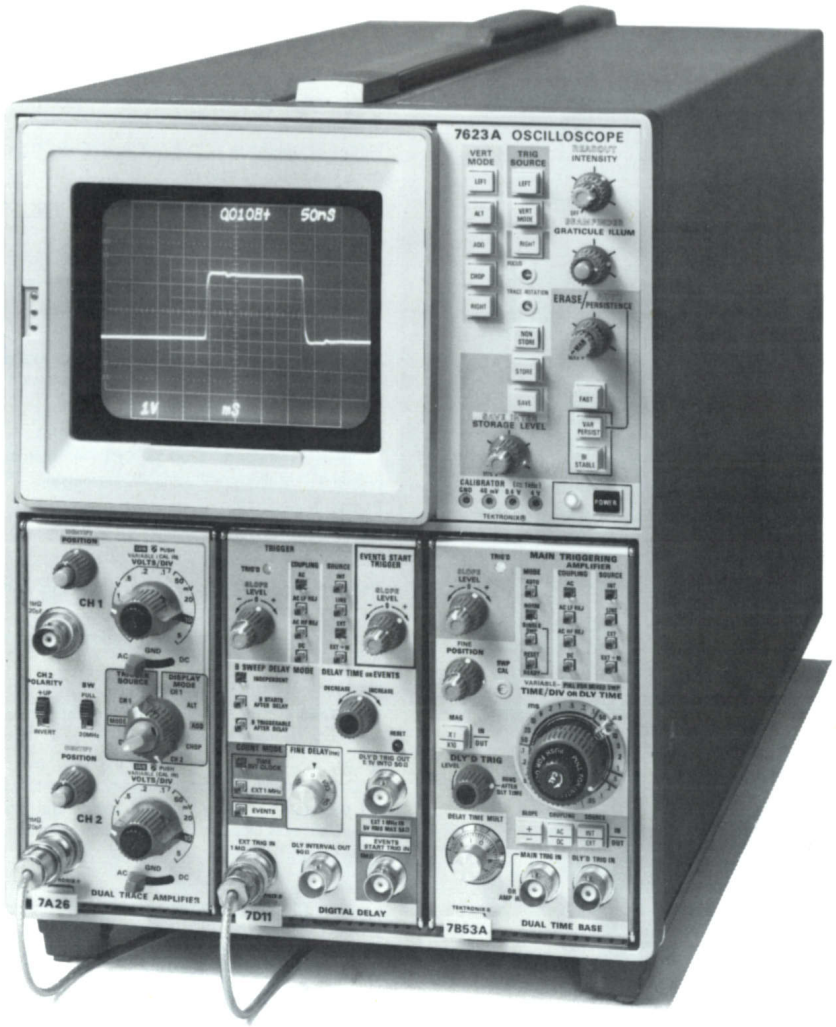
Autofocus — Reduces the need for calibrated manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

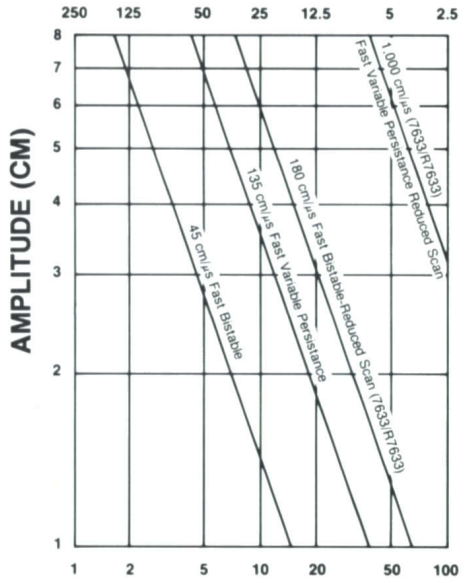
FAST VARIABLE PERSISTENCE WRITING SPEED

Scan Mode	Sweep Speed	Peak-to-Peak Sinewave	Step Response
Reduced Scan*1 2200 div/μs (0.45 cm/div)	≥5 ns/div	7.1 div 100 MHz 8 div 89 MHz	7.7 div 3.5 ns 8 div 3.7 ns
Full Scan*2 150 div/μs (0.9 cm/div)	≥50 ns/div	3.2 div 15 MHz 6.4 div 7.5 MHz	3 div 20 ns 5 div 33 ns

*1 *Applies to 7633/R7633 only.*
*2 *Applies to 7633/R7633 and 7623A/R7623A.*



STEP RISETIME (ns)



SINEWAVE FREQUENCY (MHz)

Graph showing the stored writing speed needed to display a given sinewave or step risetime at a given amplitude.

STORAGE WRITING SPEED

FULL SCAN (7633/R7633 and 7623A/R7623A)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	135 cm/μs	45 cm/μs	0.45 cm/μs	0.03 cm/μs
View Time	30 s*1	30 min minimum	30 s*1	30 min minimum
≈ Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

REDUCED SCAN (7633/R7633 Only)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Store Writing Speed	1000 cm/μs	180 cm/μs	1.35 cm/μs	0.09 cm/μs
View Time	30 s*1	30 min minimum	30 s*1	30 min minimum
≈ Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

**1 These times are at full stored display intensity. They may be increased more than 30 times by using reduced intensity in the Save display mode.*

OUTPUTS/ INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) Into 1 MΩ. Output R is 950 Ω within 2%.

+Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%,) into 1 MΩ. Risetime is 20 ns or less into 50 Ω, output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

Vertical Signal Out — Selected by Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Bandwidth depends on vertical plug-in. Output R is 950 Ω within 2%.

External Single-Sweep Reset — Ground closure; rear panel BNC provides input to reset sweep.

Remote Erase — Ground closure; rear panel BNC provides input to erase stored trace.

CAMERA POWER OUTPUT

Three-prong connector to the left of the CRT provides power, ground and remote single-sweep reset access for the C-50 Series cameras.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (15°C to 35°C); within 2% (0°C to 50°C). Rep rate is ≈1 kHz.

Current Output — 40 mA dc or 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick change jumpers.

Line Frequency — 50 Hz to 60 Hz.

Option 05, Line Frequency Change (50 Hz to 400 Hz) — Converts the 7633, R7633, 7623A and R7623A to 50 Hz to 400 Hz operation.

Maximum Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for all models.

INCLUDED ACCESSORIES

20 in two-pin-to-BNC cable (175-1178-00); green CRT filter (378-0625-08); instruction manuals. The R7633 and R7623A include rackmounting hardware.

Weights and Dimensions — See page 240.

For Recommended Cameras — See page 242.

For Recommended Plug-ins — See page 240.

For Recommended Probes — See page 240.

ORDERING INFORMATION

PLUG-INS NOT INCLUDED)

7633 Storage Oscilloscope **$8,235**

R7633 Storage Oscilloscope **$8,655**

7623A Storage Oscilloscope **$6,310**

R7623A Storage Oscilloscope **$6,725**

OPTIONS

Option 01 — Without CRT Readout ..... **−$300**

Option 03 — EMC Modification ..... **+$300**

Option 05 — Line Frequency Change (50 Hz to 400 Hz) ..... **+$300**

CONVERSION KITS

CRT Readout

Order 040-0748-01 — For Cabinet Models **$850**

Order 040-0759-01 — For Rackmount Models **$850**

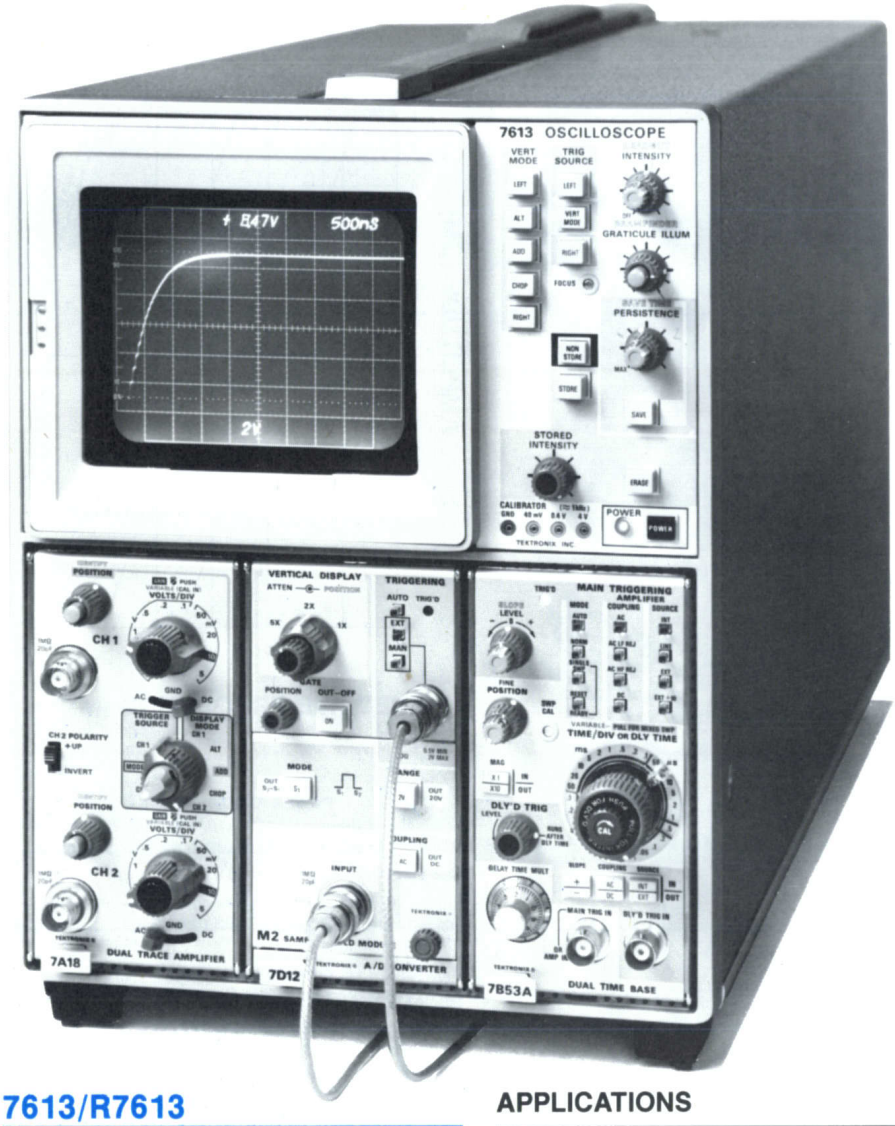
EMC Modification

Order 040-0663-01 — For Cabinet Models **$525**

Order 040-0678-01 — For Rackmount Models **$285**

Power Supply — To Light Plug-in Pushbuttons.

Order 040-0686-01 ..... **$60**



7613/R7613

4.5 cm/μs Stored Writing Speed

Long View Time

Variable Persistence Storage

Dc to 100 MHz Bandwidth

5.25 Inch Rackmount Height

APPLICATIONS

- **Audio**
- **Mechanical Transducers**
- **Spectrum Analysis**

The Tektronix 7613 Storage Oscilloscope offers variable persistence operation with a stored writing speed of 5 div/μs or nonstorage operation. Stored traces may be viewed up to 60 minutes on a display area of 8 x 10 div (0.9 cm/div).

CHARACTERISTICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit. See Vertical System Specifications Chart on page 241.

Modes of Operation — Left, Alt, Add, Chop, Right.

Chopped Mode — Rep rate is ≈1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channel — One right-hand plug-in compartment; compatible with all 7000 Series plug-ins.

Fastest Calibrated Sweep Rate — 5 ns/div.

X-Y Mode — The phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.

CRT AND DISPLAY FEATURES

Variable Persistence Storage CRT — Internal 8 x 10 div (0.9 cm/div) graticule with variable illumination.

Phosphor — GH (P31) is standard.

Option 01 — No CRT readout

Accelerating Potential — 8.5 kV.

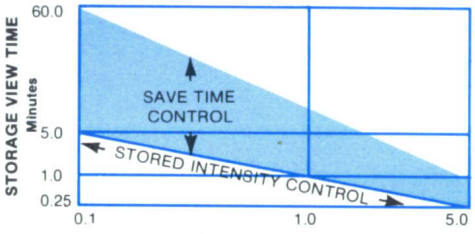
Nonstore Mode — For displaying waveforms in the conventional (nonstorage) mode.

Store Mode — For displaying waveforms using the variable persistence storage feature.

Maximum Stored Writing Speed — >4.5 cm/μs.

View Time — The view time is the amount of time the stored signal can be viewed before it fades away.

At the maximum writing speed the view time is 15 s or 0.25 minutes with the stored intensity control fully cw. Adjusting the stored intensity ccw will reduce the stored writing speed, but view time can be increased up to 5 minutes (see the chart below).



Erase Time — 0.5 s or less.

Persistence — The persistence control also varies the view time. The persistence can be adjusted from almost instantaneous disappearance (fade away), to off, which provides the view time selected by the stored intensity control.

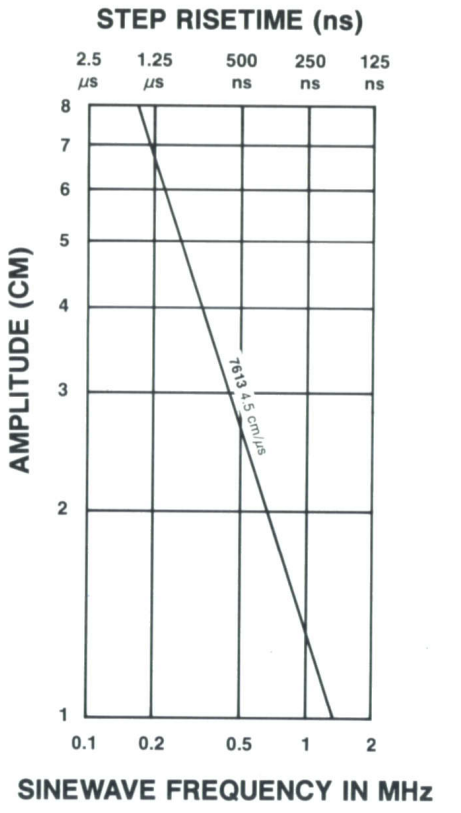
Save — Prevents erasure of the stored display and activates the save time control.

Save Time Control — Allows an extension of the view time (see Storage View Time Chart above).

External Z-Axis Input — 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.



Graph showing the stored writing speed needed for a given sinewave or step risetime at a given amplitude.

OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω within 2%.

+Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 20 ns or less into 50 Ω; output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

Sig Out — Selected by Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Bandwidth depends upon vertical plug-in. Output R is 950 Ω within 2%.

External Single-Sweep Reset — Ground closure; rear panel BNC provides input to reset sweep.

Remote Erase — Ground closure; rear panel BNC provides input to erase stored trace.

CAMERA POWER OUTPUT

Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground. (Dc voltage available when selected by internal jumper.) Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (15°C to 35°C); within 2% (0°C to 50°C). Rep rate is ≈1 kHz.

Current Output — 40 mA dc or 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick change jumpers.

Line Frequency — 50 Hz to 60 Hz.

Option 05, Line Frequency Change (50 Hz to 400 Hz) — Converts the 7613 and R7613 to 50 Hz to 400 Hz operation.

Maximum Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for both models.

INCLUDED ACCESSORIES (FOR 7613 AND R7613)

20 inch two-pin-to-BNC cable (175-1178-00); gray CRT filter (378-0625-02); instruction manual. The R7613 includes rack-mounting hardware.

Dimensions and Weight — See page 240.

For Recommended Cameras — See page 242.

For Recommended Plug-ins — See page 240.

For Recommended Probes — See page 240.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

7613 Storage Oscilloscope **$5,330**

R7613 Storage Oscilloscope **$5,750**

OPTIONS (7613)

Option 01 — Without CRT Readout ..... −$300

Option 03 — EMC Modification ..... +$300

Option 05 — Line Frequency Change (50 Hz to 400 Hz) ..... +$300

Option 06 — Special Internal Graticule (Spectrum Analyzer) ..... +$50

Option 08 — Protective Panel Cover ..... +$100

OPTIONS (R7613)

Option 01 — Without CRT Readout ..... −$300

Option 03 — EMC Modification ..... +$300

Option 05 — Line Frequency Change (50 Hz to 400 Hz) ..... +$300

Option 06 — Special Internal Graticule (Spectrum Analyzer) ..... +$50

CONVERSION KITS (7613)

CRT Readout — Order 040-0656-02 ..... $850

EMC Modification — Order 040-0663-01 ..... $525

X-Y Horizontal Comp — Order 040-0718-00 ..... $410

Power Supply — To Light Plug-in Pushbuttons. Order 040-0686-01 ..... $60

CONVERSION KITS (R7613)

CRT Readout — Order 040-0676-02 ..... $850

EMC Modification — Order 040-0678-01 ..... $285

Power Supply — To Light Plug-in Pushbuttons. Order 040-0686-01 ..... $60

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

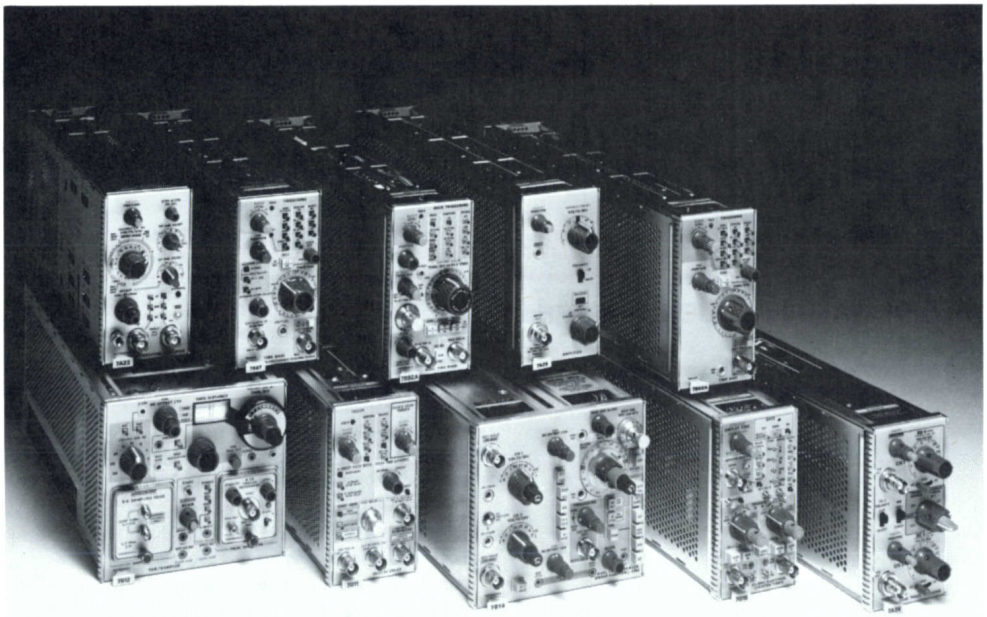
Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

7000 SERIES PLUG-INS

CONTENTS

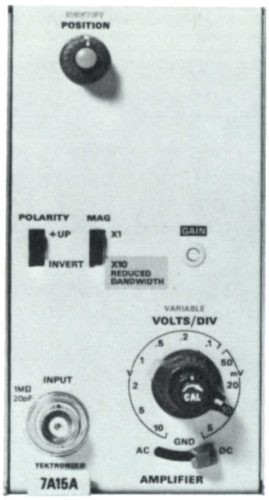
Amplifiers 263
Dc to 1 GHz Amplifiers 263
FET Probe Amplifier 265
Curve Tracer 265
Differential Amplifiers 266
Readout Unit 267
Logic Triggered Vertical Amplifier 268
Programmable and Digital Pretrigger Time Base 270
Dual Time Bases 271
Delayed and ΔDelaying Time Base 272
Single Time Base 273
Digital Delay 274
Universal Counter/Timer 275
A/D Converter 276
Digital Multimeter 276
45 ps TDR or General Purpose Sampler 279
Sampling Units to 14 GHz 280
1 GHz Dual Trace, Delayed Sweep Sampler 281
Sampling Heads to 14 GHz 282
Trigger Recognizer Heads 283
Pulse Generator Heads 283
Trigger Countdown Head 283



For the 7000 Series you can select from over forty different plug-ins. For example, the new 7A42 Logic Triggered Vertical Amplifier, digital multimeters, counters and A-D converters. With this plug-in selection you can solve problems in many applications including spectrum analysis, curve tracing, logic analysis, and sampling. This variety lets you tailor your instrument to meet your immediate need. And to expand its capabilities later as your needs change.

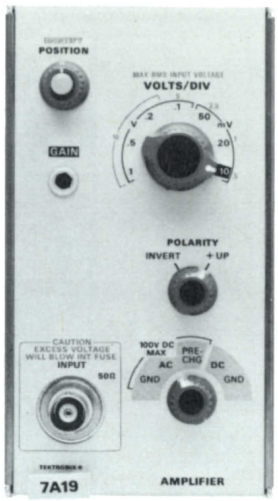
Tektronix offers service training classes on various 7000 Series plug-ins. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.

7A15A



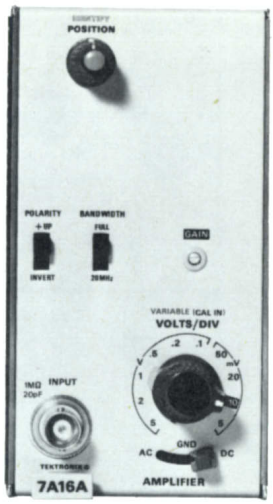
Dc to 80 MHz Amplifier

7A19



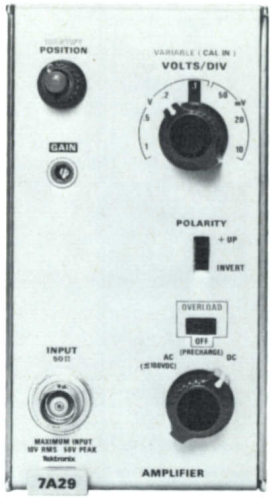
Dc to 600 MHz Amplifier

7A16A



Dc to 225 MHz Amplifier

7A29



Dc to 1 GHz Amplifier

7A15A

Dc to 80 MHz Bandwidth (7800/7900 Family)

5 mV/div to 10 V/div Calibrated Deflection Factors

500 μV/div at 10 MHz (X10 Gain)

1 MΩ Input

The 7A15A is an easy to use, 80 MHz amplifier that features a X10 magnifier to increase the sensitivity to 500 μV/div with 10 MHz bandwidth. It has a constant bandwidth at all deflection factors in the X1 setting. Polarity of the display is selectable.

CHARACTERISTICS

Deflection Factor — 5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence). X1 gain accuracy is within 2% with X1 gain adjusted at 10 mV/div. X10 gain (increases sensitivity to 500 μV) accuracy is within 10% at 10 MHz bandwidth throughout deflection factor settings. Uncalibrated variable is continuous between steps to at least 25 V/div.

Input R and C — 1 MΩ within 2%; ≈20 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum 1 kHz or less. Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less.

Included Accessory — Instruction manual.

Order 7A15A Amplifier **$635**

7A19

The 7A19 is a high-performance, wide band, single-trace, plug-in amplifier designed primarily for use with the 7100, 7700, 7800, and 7900 Family mainframes. The polarity of the display is selectable, either normal or inverted.

The recommended replacement for the 7A19 is the 7A29.

Included Accessory — Instruction manual.

ORDERING INFORMATION

7A19 Amplifier **$2,450**

Option 04 — Variable Signal Delay ..... **+$350**

7A16A

Dc to 225 MHz Bandwidth (7900 Family)

5 mV/div to 5 V/div Calibrated Deflection Factors

1 MΩ Input

The 7A16A is an easy to use 225 MHz amplifier. It features constant bandwidth over the deflection factor range of 5 mV/div to 5 V/div. Polarity of the display is selectable; bandwidth is selectable to Full or limited to 20 MHz for low-frequency applications.

CHARACTERISTICS

Deflection Factor — 5 mV/div to 5 /div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. Uncalibrated variable is continuous between steps to at least 12.5 V/div.

Input R and C — 1 MΩ within 2%; ≈20 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less.

Dc Stability — Drift with ambient temperature (constant line voltage) is 0.01 div/°C. Drift with time (ambient temperature and line voltage constant) is 0.02 div in any one minute after 1 hour warm-up.

Included Accessory — Instruction manual.

Order 7A16A Amplifier **$1,165**

7A29

Dc to 1 GHz Bandwidth (with 7104)

10 mV/div to 1 V/div Calibrated Deflection Factors

50 Ω Input

Optional ±500 ps Variable Delay Line

The 7A29 is a high performance, wide-bandwidth, single-trace, plug-in amplifier designed primarily for use with the 7700, 7800, 7900, and 7100 Series mainframes. The polarity of the display is selectable, either normal or inverted. RMS sensed input protection protects the 7A29 against most common overloads.

CHARACTERISTICS

Deflection Factor — 10 mV/div to 1 V/div in seven calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 0.1 V/div. Uncalibrated variable is continuous between steps to at least 2.5 V/div with some bandwidth reduction.

Input R — 50 Ω.

Ac Coupling — −3 dB at 1 kHz or less from a 50 Ω source.

Option 04, Variable Signal Delay — Permits matching the transit time of two preamps and probes to better than 10 ps. Range is ±500 ps.

Maximum Input — 10 V RMS or 1 W-second pulses not exceeding 50 V peak in dc coupled mode. 100 V dc additional in ac coupled mode.

Input Protection — Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated, and has manual reset.

Included Accessory — Instruction manual.

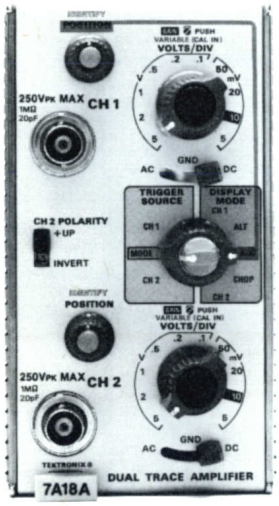
ORDERING INFORMATION

7A29 Amplifier **$2,685**

Option 04 — Variable Signal Delay ..... **+$350**

For recommended probes—refer to page 240.

7A18A



Dc to 75 MHz Dual Trace Amplifier

7A18A

Dc to 75 MHz Bandwidth

5 mV/div to 5 V/div Calibrated Deflection Factors

1 MΩ Input

Optional Dc Offset

The 7A18A, the basic building block of three- and four-trace operation, is a dual-trace plug-in amplifier. The 7A18A features constant bandwidth for all deflection factors, five operating modes (CH 1, CH 2, Alt, Chop, Add), trigger source selectivity and color-keyed control grouping. The 7A18A has a trace identify function. Polarity of Channel 2 is selectable.

CHARACTERISTICS

Deflection Factor — Calibrated: 5 mV/div to 5 V/div in ten steps (1-2-5 sequence). Accuracy: Within 2% with gain adjusted to 10 mV/div. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

Input R and C — 1 MΩ within 2%; ≈20 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less.

Dc Stability — Drift with Ambient Temperature (Constant Line Voltage): 0.01 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after 1 hr warm-up.

Common-Mode Rejection Ratio (Add, CH 2 Invert) — At least 10:1, dc to 50 MHz.

Included Accessory — Instruction manual.

Order 7A18A Amplifier **$1,250**

DC OFFSET OPTION

Dc Offset is for the user who needs to analyze small signals that are riding on larger signals, such as power supply ripple.

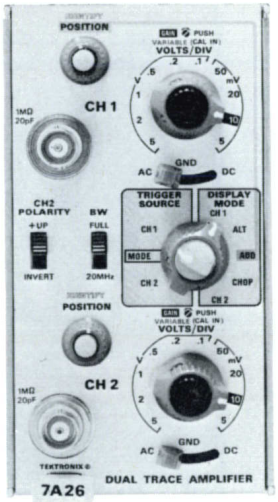
Option 06, Dc Offset — Separate Channel 1 and Channel 2 variable Offset controls are concentric with the position controls replacing the identify push-buttons of the standard 7A18A. The ac-dc-ground switch of each channel is expanded to accommodate a fourth position for dc offset.

Offset Range Display — ±200 division maximum, equivalent to ±1 V at 5 mV/div.

Accuracy — When in dc Offset the deflection accuracy is derated by 1%.

Order Option 06 Dc Offset ..... **+$200**

7A26



Dc to 200 MHz Dual Trace Amplifier

7A26

Dc to 200 MHz Bandwidth (7900 Family)

5 mV/div to 5 V/div Calibrated Deflection Factors

1 MΩ Input

The 7A26, a dual-trace plug-in amplifier, is a basic building block for three- or four-trace operation. It features constant bandwidth for all deflection factors, five operating modes (CH 1, CH 2, Alt, Chop, Add), trigger source selection (CH 1, CH 2, Mode), and color-keyed control groupings. Polarity of Channel 2 is selectable. Bandwidth may be set at Full or limited to 20 MHz for low-frequency applications.

CHARACTERISTICS

Deflection Factor — Calibrated: 5 mV/div to 5 V/div in 10 steps (1-2-5 sequence). Accuracy: Within 2% with gain adjusted at 10 mV/div. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

Input R and C — 1 MΩ within 2%; ≈22 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less.

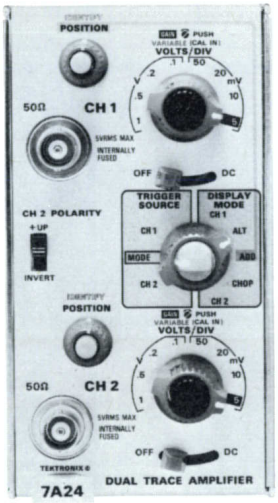
Common-Mode Rejection Ratio (Add, CH 1 Invert) — At least 10:1, dc to 50 MHz.

Dc Stability — Drift with Ambient Temperature (Constant Line Voltage): 0.02 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 division in any 1 minute after 1 hr warm-up.

Included Accessory — Instruction manual.

Order 7A26 Amplifier **$2,025**

7A24



Dc to 400 MHz Dual Trace Amplifier

7A24

Dc to 400 MHz Bandwidth (7104)

5 mV/div to 1 V/div Calibrated Deflection Factors

50 Ω Input

The 7A24, high-performance, wide band, dual-trace amplifier, is designed primarily for use with the 7700, 7800, 7900, and 7100 Series mainframes. The 7A24 offers 400 MHz bandwidth and 5 mV/div sensitivity; this provides the basic building block for three- or four-trace operation. It features constant bandwidth for all deflection factors, five operating modes (CH 1, CH 2, Alt, Chop, Add), trigger source selection (CH 1, CH 2, Mode), and color-keyed control groupings. Polarity of Channel 2 is selectable.

CHARACTERISTICS

Deflection Factor — Calibrated: 5 mV/div to 1 V/div in eight steps (1-2-5 sequence). Accuracy: Within 2% with gain adjusted to 5 mV/div. Uncalibrated: Variable is continuous between steps to at least 2.5 V/div.

Input R — 50 Ω within 0.5%; vswr 1.25:1 or less at 5 mV/div and 10 mV/div, 1.15:1 or less from 20 mV/div to 1 V/div at 250 MHz.

Maximum Input Voltage — 5 V RMS; 0.5 W maximum input power, internally protected.

Common-Mode Rejection Ratio — At least 10:1, dc to 50 MHz.

DC Stability — Drift with Ambient Temperature (Constant Line Voltage): 0.02 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after 1 hr warmup.

Included Accessory — Instruction manual.

Order 7A24 Amplifer **$2,360**

For recommended probes—refer to page 240.

7A11

Built-In FET Probe

Dc to 250 MHz Bandwidth (7900 Family)

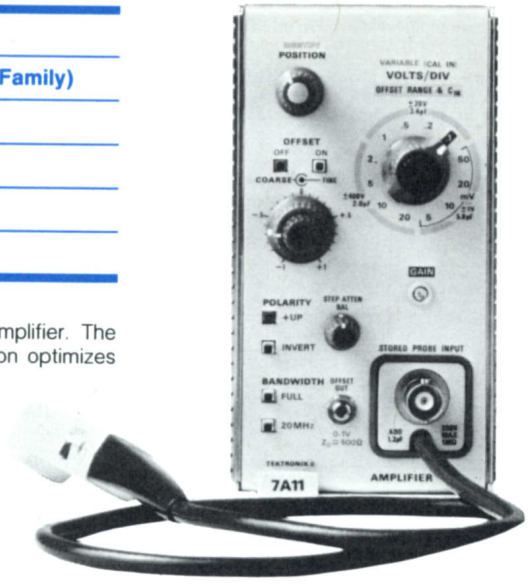
5 mV/div to 20 V/div

Calibrated Deflection Factors

Dc Offset

1 MΩ Input

The 7A11 is a wideband plug-in amplifier. The captive FET probe input configuration optimizes signal acquisition with high resistance (1 MΩ) and low capacitance (5.8 pF at 5 mV/div), without loss of signal amplitude by probe attenuation. Two 20X attenuators, physically mounted in the probe tip, are relay-switched into the input signal path at the appropriate deflection factor. Therefore you need not concern yourself with manual plug-on attenuators and signal dynamic range.



Amplifier

CHARACTERISTICS

Deflection Factor — 5 mV/div to 20 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2% of gain adjustment at 0.1 V/div. Uncalibrated Variable is continuous between steps to at least 50 V/div.

Input R and C — 1 MΩ within 1%; ≈5.8 pF (5 mV/div to 50 mV/div), ≈3.4 pF (0.1 V/div to 1 V/div), ≈2 pF (2 V/div to 20 V/div).

Signal and Offset Range

Deflection Factor Settings	5 mV/div to 50 mV/div	0.1 V/div to 1 V/div	2 V/div to 20 V/div
Offset Range	+1 V to −1 V	+20 V to −20 V	+400 V to −400 V
Offset Range to Offset Out	1:1 within 1% +0.5 mV	20:1 within 1.5% +0.5 mV	400:1 within 2% +0.5 mV
Maximum Dc Coupled Input	200 V (dc + peak ac, ac component to 50 kHz)	200 V (dc + peak ac, ac component to 40 MHz)	200 V (dc + peak ac, ac component to 70 MHz)
Maximum Ac Coupled Input (Dc Component)	±200 V		

Dc Stability — Drift with time (constant ambient temperature and line voltage): Short term is 0.1 div or less per minute after 20 minute warm-up. Long term is 0.3 div or less per hour after 20 minute warm up. Drift with ambient temperature (constant line voltage), 200 μV/°C or less.

Displayed Noise — 0.5 mV or 0.1 div, whichever is greater, in Full Bandwidth mode, measured tangentially.

Offset Function — An internal dc source, continuously variable between +1 V and −1 V, may be used to offset the trace. (See chart for offset range.) An Offset Out jack allows for monitoring of the offset voltage. Offset Out source resistance is 500 Ω within 3%.

INCLUDED ACCESSORIES

Capacitor-coupler head (011-0110-00); retractable hook tip (013-0106-00); probe tip ground adaptor (013-0085-00); 3 inch nose ground lead (175-0849-00); 3 inch screw-in ground lead (175-0848-00); 12 inch screw-in ground lead (175-0848-02); 18 inch offset out cable (175-1092-00); three miniature alligator clips (344-0046-00); probe hook tip (206-0114-00); 2 insulated sleeves (166-0404-01); probe tip to GR 50 Ω termination (017-0088-00); instruction manual.

Order 7A11 Amplifier **$2,700**

7A17

Low Cost

Dc to 150 MHz Bandwidth (7900 Family)

50 mV/div Calibrated Deflection Factor

Easy to Customize

The 7A17 is a unique wideband, plug-in amplifier electrically and mechanically suitable for do-it-yourself design and modification.

The layout of the circuit board assembly provides a blank soldering pad matrix and ground plane surface totaling approximately 40 square inches. Circuits may be installed here. Mainframe power is identified and available on the circuit board. The front sub-panel is prepunched with holes of various sizes and shapes which allow for the mounting of connectors, switches, indicators, etc.

CHARACTERISTICS

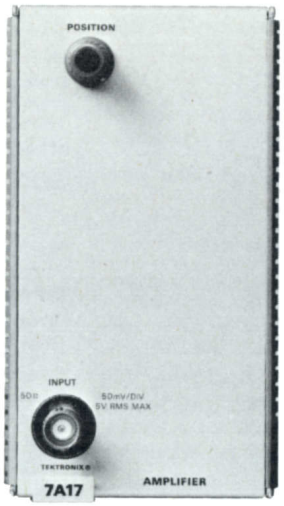
Deflection Factor — Adjustable to 50 mV/div. There is no step attenuation.

Input Z — 50 Ω.

Maximum Input Voltage — 5 V RMS.

Included Accessory — Instruction manual.

Order 7A17 Amplifier **$415**



Amplifier

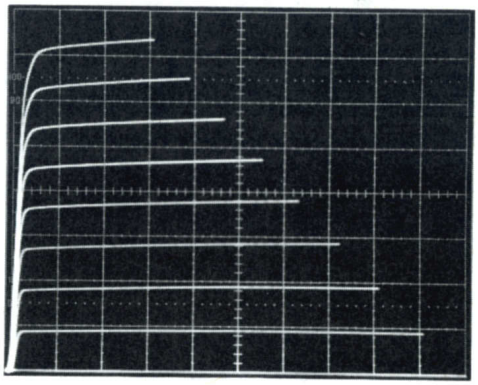
Curve Tracer

7CT1N

10 nA/div to 20 mA/div Vertical Deflection Factors

0.5 V/div to 20 V/div Horizontal Deflection Factors

The 7CT1N Curve Tracer Plug-in displays characteristic curves of small-signal semiconductor devices to power levels up to 0.5 W. The 7CT1N operates in horizontal or vertical compartments of 7000 Series oscilloscopes.



2N3904 transistor characteristic generated by the 7CTIN. Control settings are indicated on front panel of 7CTIN.
Vertical — 2 mA/div
Horizontal — 0.5 V/div
Base Current — 10 μA/step

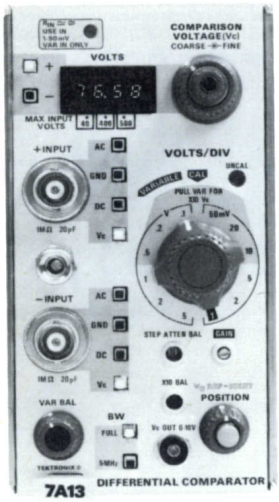
Included Accessory — Instruction manual.

Order 7CT1N Curve Tracer **$1,470**

For more Information on the 7CT1N see page 415 in Curve Tracer section.

For recommended probes—refer to page 240.

7A13



Differential Comparator Amplifier

7A13

Dc to 105 MHz Bandwidth (7900 Family)

1 mV/div to 5 V/div Calibrated Deflection Factors

20,000:1 CMRR

10,000 cm Effective Screen Height

1 MΩ Input Switchable to ∞

The 7A13 is a differential comparator amplifier. It incorporates a number of features which make it particularly versatile, especially in multitrace combination with other 7000 Series vertical plug-ins.

The 7A13 has constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable to Full or 5 MHz for best displayed noise conditions for low-frequency applications.

As a differential amplifier the 7A13 provides a balanced (+ and −) input for applications requiring rejection of a common-mode signal. The CMRR is 20,000:1 from dc to 100 kHz, derating to 200:1 at 20 MHz. The unit can reject up to 10 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 100 V rejection potential at 10 mV/div (X10 Vc pulled) and 500 V at 0.1 V/div.

As a comparator amplifier the 7A13 loses its differential capability, but provides an accurate (0.1%) positive or negative internal offsetting voltage covering the common-mode signal range of the unit. A signal of up to ±10 V may be applied to an input (+ or −) at a deflection factor setting of 1 mV/div and, with an opposing Vc (offset voltage), viewed in 10,000 segments of 1 mV. The offset voltage is also available as an output for external monitoring.

CHARACTERISTICS

Input R and C — 1 MΩ within 0.15%; ≈20 pF. R in ≈∞, is available in the 1 mV to 50 mV/div range, selectable by an internal switch.

Deflection Factor — 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 1.5% with gain adjusted at 1 mV/div. Uncalibrated Variable is continuous between steps to at least 12.5 V/div.

Signal Range

Deflection Factor Settings	1 mV to 50 mV/div	10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div	0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div
Common-mode Signal	±10 V	±100 V	±500 V
Maximum Dc Coupled Input (dc + Peak Ac at 1 kHz or less)	±40 V	±400 V	±500 V
Maximum Ac Coupled Input (dc Voltage)		±500 V	

Maximum Input Gate Current — 0.2 nA or less from 0°C to +35°C; 2 nA or less at +35°C to +50°C.

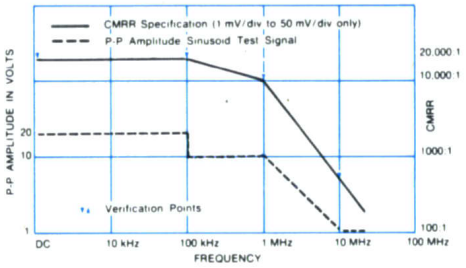
Dc Stability — Drift with Time (Constant Ambient Temperature and Line Voltage): Short term is 1 mV p-p or 0.1 div, or less (whichever is greater) over any 1-minute interval after 20 minute warm-up. Long term is 1 mV p-p or 0.1 div or less (whichever is greater) during any 1 hr interval after 20 minute warm-up. Drift with Ambient Temperature (Constant Line Voltage): 2 mV/10°C to 0.2 div/10°C or less, whichever is greater.

Displayed Noise (Tangentially Measured) — With X10 Vc in, 400 μV (200 μV RMS) or less at 1 mV/div; 0.2 div or less at 2 mV/div to 5 mV/div; 0.05 div or less at 10 mV/div to 5 V/div. With X10 Vc out, 0.4 div or less at 10 mV/div to 0.5 V/div.

Overdrive Recovery — 1 μs to recover to within 2 mV and 0.1 ms to recover to within 1 mV after a pulse of ±10 V or less at 1 mV/div only, regardless of pulse duration.

Internal Comparison Voltage — Range: 0 V to ±10 V; Accuracy: ±(0.1% of setting +3 mV); Vc Output R: ≈15 kΩ.

Common-Mode Rejection Ratio



At least 2000:1, 10 mV/div to 50 mV (X10 Vc out) and 0.1 V/div to 5 V/div. Ac coupled input at least 500:1 at 60 Hz.

Included Accessory — Instruction manual.

Order 7A13 Amplifier **$3,040**

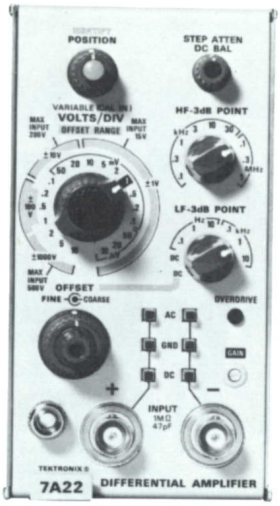
High CMRR Probes for Differential Amplifiers

We recommend the P6055 high CMRR adjustable 10X probes for use with Tektronix differential amplifiers.

When used in pairs, these probes allow adjustment for maximum CMRR (common-mode rejection ratio).

See page 455 for P6055 characteristics.

7A22



Differential Amplifier

7A22

Dc to 1 MHz Bandwidth

10 μV/div to 10 V/div Calibrated Deflection Factors

100,000:1 CMRR

Selectable Upper and Lower −3 dB Points

Dc Offset

10 μV/Hour Dc Drift*[1]

1 MΩ Input

The 7A22 is a differential amplifier well suited for difficult low-amplitude, low-frequency measurements.

CHARACTERISTICS

Bandwidth — HF: −3 dB point; selectable in nine steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 10% of selected frequency; risetime in 1 MHz position is 350 ns ±9%. LF: −3 dB point; selectable in six steps (1-10 sequence) from 0.1 Hz to 10 kHz, accurate within 12% of selected frequency. The switch also contains dc and dc with Offset positions. Ac coupled at input, 2 Hz or less.

Deflection Factor — 10 μV/div to 10 V/div in 19 calibrated steps (1-2-5 Sequence). Accuracy is within 2% with gain adjusted to 1 mV/div. Uncalibrated Variable is continuous between steps to at least 25 V/div.

Input R and C — 1 MΩ within 1%; ≈47 pF.

Maximum Input Gate Current — Differentially measured, 40 pA (+25°C) and 200 pA (+50°C) at 10 μV/div to 10 mV/div; 10 pA (+25°C) and 20 pA (+50°C) at 20 mV/div to 10 V/div.

Single ended, one-half the differential measurement. Display shift is ±4 division (+25°C) and ±20 division (+50°C) at 10 μV/div (ac coupled).

Signal and Offset Range

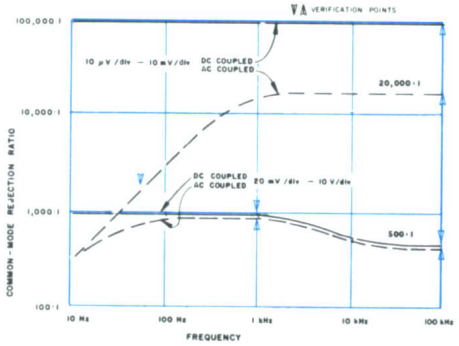
Deflection Factor Settings	10 μV to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
Common-Mode Signal Range	±10 V	±100 V	±500 V	
Maximum Dc Coupled Input (dc + peak ac at 1 kHz or less)	±15 V	±200 V	±500 V	
Maximum Ac Coupled Input (dc voltage)	±500 V dc rejection, at least 4 x 10^5:1			
Dc Offset Range	+1 V to −1 V	+10 V to −10 V	+100 V to −100 V	+1000 V to −1000 V

Dc Stability — Drift with Time (Constant Ambient Temperature and Line Voltage): Short term is 5 μV (p-p) or 0.1 div, whichever is greater in any minute after one hour warm-up. Long term is 10 μV (p-p) or 0.1 div, whichever is greater in any hour after one hour warm-up. Drift with Ambient Temperature (Constant Line Voltage): 50 μV/°C or less.

Displayed Noise — 16 μV or 0.1 div (whichever is greater) at maximum bandwidth; source resistance 25 Ω or less measured tangentially.

Overdrive Recovery — 10 μs or less to recover within 0.5% of zero level after removal of a test signal applied for 1 s (signal amplitude not to exceed differential dynamic range). Front-panel Overdrive light indicates that an overdrive condition is being approached.

Common-Mode Rejection Ratio (for signals not exceeding common-mode signal range)



Included Accessory — Instruction manual.

Order 7A22 Amplifier **$1,590**

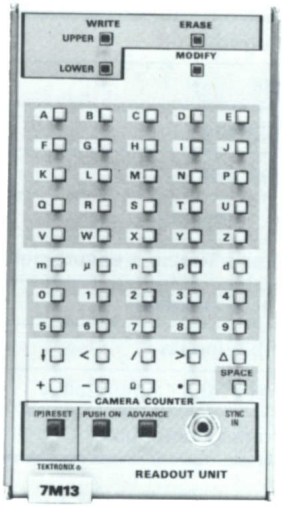
High CMRR Probes for Differential Amplifiers

We recommend the P6055 high CMRR adjustable 10X probes for use with Tektronix differential amplifiers.

When used in pairs, these probes allow adjustment for maximum CMRR (common-mode rejection ratio).

See page 455 for P6055 characteristics.

7M13



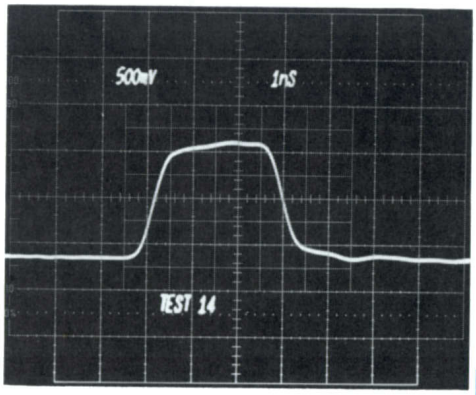
Readout Unit

7M13

Easy and Convenient Identification of Photographed Displays

Automatic Sequence Advance with Each Camera Exposure

The 7M13 Readout Unit provides front-panel keyboard operation for convenient access to the CRT readout characters. Up to ten alphanumeric characters can be displayed at the top and/or at the bottom of the CRT. The 7M13 is designed for use in all 7000 Series mainframes with CRT readout. A remote-advance cable is supplied with the 7M13 to connect it to the shutter X-sync connector of the C-50 Series cameras. An optional cable is available for cameras using an ASA connector for X-sync.



The photograph above was identified as TEST 14 by using the 7M13 in 7834 Oscilloscope.

INCLUDED ACCESSORIES

Remote-advance cable (012-0339-01); instruction manual.

Order 7M13 Readout Unit **$1,075**

Optional Accessory — Remote-advance cable with ASA connector for camera X-sync.

Order 012-0364-01 ..... **$25**

[1] With constant temperature. See dc stability specifications.

NEW

7A42

- Up to 350 MHz Bandwidth
- Four Input Channels
- Boolean Logic Triggering
- Nested Trigger Functions
- Variable Switching Thresholds
- Precise Amplitude and Timing Measurement
- External Clock Synchronization
- 1 MΩ/50 Ω Switchable Inputs
- Variable/Bias Offset Probe Compatibility
- 7000 Series Mainframe Compatible

The 7A42 Logic Triggered Vertical Amplifier is a two-wide 7000 Series plug-in that provides a significant new dimension to oscilloscope measurements through the combination of oscillsocope and logic analyzer technologies. The 7A42 logic triggering permits digital signals to be displayed in analog form for high resolution measurements of both time and amplitude characteristics.

High Resolution Analog Display of Digital Signals

Very accurate analog representations of digital signals are displayed. Input attenuators can be optimized for either TTL or ECL logic families. A 1 ns risetime with 200 ps or less delay difference between the four input channels provides precise, high resolution timing measurements. Unlike a logic analyzer's timing display, the 7A42 accurately displays risetimes and falltimes, allows pulse width to be precisely measured, enables pulse aberrations to be viewed and quantified, and amplitude to be measured with confidence.

Advanced Logic Triggering

Triggers are generated by the 7A42 upon recognition of preprogrammed Boolean combinations of logic levels and transitions at any or all of its input channels. Independently variable switching thresholds and edge sensitivity make triggering on digital signals an easy task.

Nested Triggering Functions

One level of nested triggering is implemented in the 7A42. Triggers may be generated on event "A", event "B", or on "A then B". In "A then B" mode, the 7A42 arms on event A, and generates a trigger to a time base on the next occurrence of event B. A reset input disarms the 7A42 in nested triggering mode at any time. Nested triggering provides the flexibility needed to trigger on even the most complex digital event.

See The Trigger Event

Delay lines in the 7A42 permit the trigger event to be displayed in its entirety. A representation of the 7A42 Trigger Out signal can be displayed on the mainframe CRT. This Trigger View trace shows where the trigger event occurred and how long it lasted.

Trigger Filtering Prevents Inadvertent Triggering

A continuously variable (equal to or greater than 300 ns) trigger filter control eliminates unnecessary or inadvertent triggering by requiring that a trigger function remain true longer than the Trigger Filter setting.

External Clock Synchronization

An external clock input allows further qualification of a triggering event to coincide with either a positive or negative transition of an external clock signal. This input is compatible with either TTL or ECL levels.

Special Probe Features

The 7A42 Probe Offset accommodates the new P6230 Variable Bias/Offset Probe, which is ideal for probing ECL circuits with reduced loading. The P6230 is a 1.5 GHz, 450 Ω probe with the ability to place bias voltage at its tip. A wide variety of accessories, including very flexible grounding schemes, make the P6230 ideal for high speed digital circuit testing. The P6131 10X high impedance probe is the recommended probe for TTL, high speed TTL, CMOS and other high impedance logic families.

Easy Setup

CRT readout of attenuator settings and the display of error messages designed to guide a user through the process of setting up the instrument make the 7A42 easy to operate. The use of multicolored LEDs communicate the status of other 7A42 functions at a glance. A battery backup system preserves the current settings when power is removed and reapplied, thus saving setup time.

CHARACTERISTICS

VERTICAL SYSTEM

Input — Four channels, BNC connectors.

Deflection Factor — Calibrated Through 10X Probe: TTL (CMOS) family is 1, 2, 5 V/div. ECL family is 0.2, 0.5, 1 V/div. Gain Accuracy: Within 3%.

Bandwidth — To 350 MHz maximum. See 7000 Series Vertical System Specifications on page 241 for frequency response in specific mainframes.

Input Impedance — Selectable between 1 MΩ and 50 Ω. High Impendance: 1 MΩ ±1%, in parallel with ≈15 pF. Low Impedance: 50 Ω ±1 Ω at dc. Vswr is ≤1.15:1, dc to 300 MHz.

Maximum Input Voltage — 1 MΩ: 25 V (dc + peak ac) 36 MHz or less, derated linearly to 3 V (peak ac) at 300 MHz. 50 Ω: 5 V RMS during any 1 ms time interval. Active internal-protection opens all inputs if overvoltage is applied to any channel.

Dc Stability — Drift with Time: Not more than 0.2 div in any 10 min after 20 min warmup. Drift with Temperature: Not more than 0.2 div for 10°C ambient change.

Differential Delay — 200 ps maximum between the four input channels.

Trigger View or External Clock View — Time Coincidence with Channel Display: Trigger View is within 3 ns. External Clock View is within 5 ns.

TRIGGER SYSTEM

Switching Threshold — Voltage Range*1 : TTL (CMOS) family is +12.8 V to −12.7 V. ECL family is +2.56 V to −2.54 V. Accuracy*2: TTL (CMOS) family is ±50 mV ±2% of setting. ECL family is ±10 mV ±2% of setting.
Presets*1: TTL (CMOS) is +1.4 V. ECL is −1.3 V. Probe Offset activated is 0 V.

Tip (Probe Offset) Input — Maximum Voltage Range: +5.1 V to −5.1 V, dc only. DVM Accuracy: ±20 mV ±2% of reading.

Trigger Filter — Range: Off, or adjustable from <15 ns to >300 ns. Match, Trigger Function A to Trigger Function B: Within 20% at maximum setting.

Ext Clock Input — Maximum Voltage Range: +5 V to −5 V (dc + peak ac). Threshold: Two Ext Clock Input modes are available, TTL or ECL. TTL level at logic zero is ≤0.8 V; at logic one is ≥2 V. ECL level at logic zero is ≤−1.5 V; at logic one is ≥−1.1 V. Input Impedance: TTL level is ≈10 KΩ in parallel with ≈55 pF, terminated to +5 V, compatible with a 1X probe. ECL level is ≈50 Ω, terminated to −2 V. Pulse Width: TTL level is 20 ns minimum, either pulse transition selected. ECL level is 5 ns minimum, leading pulse transition selected; or 10 ns minimum, trailing pulse transition selected. Setup Time: 10 ns minimum. Hold Time: 10 ns minimum.

Channel Edge Sensitivity — Setup Time, Channel to Channel: 5 ns minimum (time that level sensitive portion of trigger function must be true before Edge sensitive channel transition). Hold Time, Channel to Channel: 5 ns minimum, (time that level sensitive portion of trigger function must remain true after Edge sensitive channel transition). Setup Time, Edge Sensitive Channel: 10 ns minimum (time that level of Edge sensitive channel must be stable before transition). Hold Time, Edge Sensitive Channel: 5 ns minimum (time that level of Edge sensitive channel must remain stable after transition).

Trigger Out Connector — Output Voltage: 1 V into 50 Ω. Output Impedance: ≈50 Ω. Toggle Frequency: 125 MHz maximum. Propagation Delay: Channel Input to Trigger Output is 25 ns or less. A then B Mode: Time between A and B is 5 ns minimum (minimum setup time from event A to event B). Time from B to A is 5 ns minimum (minimum time after event B to next event A). Event Duration (minimum time to insure proper arming and triggering): Event A is 5 ns minimum. Event B is 5 ns minimum. Front panel A then B Gate Output: Active only if selected and in the A then B mode.

*1 *At tip of 10X probe with readout compensation.*

Mainframe A Then B Gate Output — Active only in A then B mode. Pulse Width (Measured at the 50% Points): > the time between event A and event B by 5 ns ±2 ns.

Reset Input — Maximum Input Voltage: +5 V to −5 V (dc + peak ac). Input Impedance: ≈50 Ω. Logic Zero Level: ≤0.2 V. Logic One Level: ≥0.8 V. Pulse Width: 100 ns minimum. Timing (Post-Reset Inhibit Time to Next Trigger): 10 ns minimum (time from falling edge of Reset to next recognizable event). Response Time: Reset pulse must lead or be coincident with event recognition to inhibit trigger output. Event recognition must lead the Reset pulse by 10 ns to guarantee trigger output.

BATTERY BACKUP

Ni-Cad Battery (3.75 V) — Provides power to preserve front panel control status a minimum of 200 hours while main power is off. Battery requires about 24 hours to fully charge from discharged condition.

OTHER CHARACTERISTICS

Net Weight — ≈2.8 kg (6.2 lb).

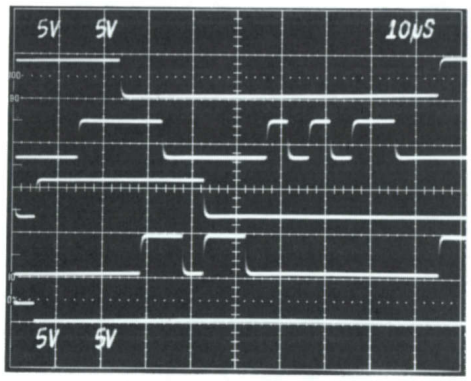
Shipping Weight — ≈7.2 kg (16.0 lb).

Included Accessories — Instruction manual.

Order 7A42 Logic Triggered Vertical Amplifier **$5,950**

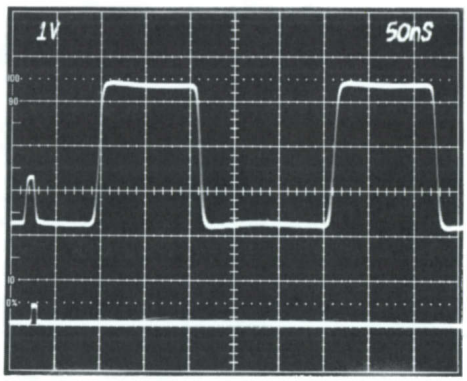
NEW

Four Channel Analog Display with Trigger View



Up to four logic signals can be displayed by the 7A42 in true analog form. Additionally, the Trigger View trace provides the ability to view exactly when the programmed Trigger Function is satisfied.

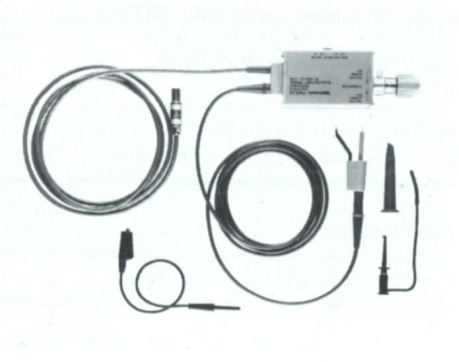
Selective Triggering on a Low Amplitude Pulse



Independent and variable trigger thresholds for each of the four input channels allow selective triggering on an abnormally low amplitude pulse (indeterminate state) within a pulse train. Shown above, two channels are used to establish dual thresholds to bracket the low level pulse. The 7A42 triggers on any signal that remains between the two thresholds longer than the time set by the Trigger Filter.

OPTIONAL ACCESSORIES

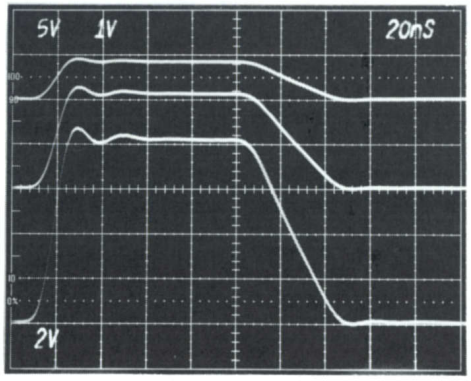
NEW P6230 Variable Bias/Offset 10X Probe



The P6230 probe is recommended for high speed ECL probing. It is a very low capacitance, high bandwidth, probe ideal for ECL and features a variable bias/offset that minimizes its dc loading on the circuit. See page 442 for details.

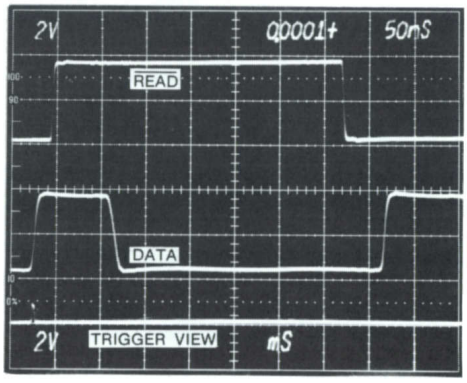
Order P6230 10X Circuit Probe **$385**

Range of Sensitivities



Three display sensitivities are available for each of the logic families. Select the most convenient display size for the application; small amplitudes for many traces on the screen, or large sizes when more signal detail is desired.

Edge Sensitive Triggering



Data bus transitions are generally not allowed during a specified time at the end of a microprocessor read cycle. In the above display, the 7A42 has captured a positive transition of a data line during the time when data should have been stable (note trigger view pulse). The 7A42's Edge Sensitivity enhances its Boolean triggering by detecting rising or falling transitions of one signal during a time qualified by the states of the other channels.

NEW P6131 Passive 10X Probe

The P6131 is a general purpose probe, ideal for use with TTL and CMOS circuits, and is recommended for use with the 7A42 for up to 300 MHz system bandwidth. See page 450 for details.

Order P6131 Passive 10X Probe **$135**

7B80/7B85/7B87

1 ns/div to 5 s/div Calibrated Time Bases

Triggering to 400 MHz

Variable Trigger Holdoff

Peak-to-Peak Auto Triggering

7B85 Features:

ΔTime Measurements with CRT Readout

Delayed Time Measurements with CRT Readout

Vertical Trace Separation Between Two Delayed Sweeps

7B87 Features:

Pretrigger When Used with 7854

The 7B80, 7B85 and 7B87 are horizontal time bases recommended for use with 7700, 7800 and 7900 Series mainframes to provide optimum bandwidth/sweep-speed compatibility. (Each may be used in any slower 7000 Series mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

Each plug-in can be used separately as an independent single time base, or combined in any mainframe with two horizontal compartments for delaying and delayed operation.

X-Y displays are available using a 7B80 with Option 02. A front-panel button (Display Mode) selects normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers, and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B80. An X-Y mode selection then applies the signal to the horizontal deflection system. This option is appropriate where the user is making Y-T and X-Y measurements and changing the amplifier frequently from the vertical compartment to the horizontal compartment is not acceptable.

The 7B87 is designed for use with the 7854 Mainframe to provide additional pretrigger capability. The pretrigger feature is only compatible with the 7854 at this time. When used in the B horizontal of the 7854, the 7B87 provides both single shot and pretrigger capability to the 7854.

Pretrigger allows you to view what has occurred before the trigger event in single shot applications. The amount of pretrigger time is determined by the Acquire-Stop delay time setting. The total amount of pretrigger is 0.2 to 9.9 times the time/div setting.

The Int ÷ 1000 control reduces the stored time/div to 1000 times slower than the real time display on a 7854. This does not, however, affect the Acquire-Stop delay time. The Int ÷ 1000 control allows stored sweep speeds from 10 ms to 5000 s/div for slow speed applications.

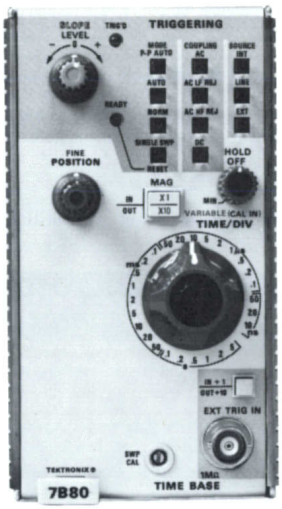
An Ext Clock-In connector is provided for clock frequencies other than what is offered by the Int clock of the 7B87.

CHARACTERISTICS

Characteristics are common to all three units unless otherwise noted.

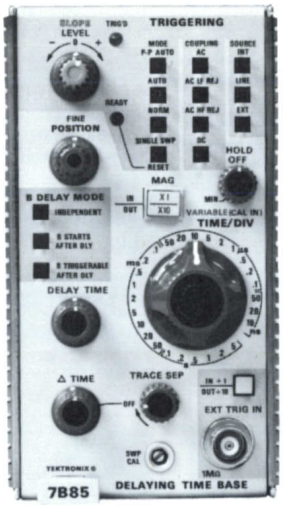
Sweep Rates — 5 s/div to 10 ns/div in 27 steps (1-2-5 sequence). X10 Magnifier extends fastest calibrated sweep rate to 1 ns div. The uncalibrated Variable is continuous to at least 2.5 times the calibrated sweep rate.

7B80



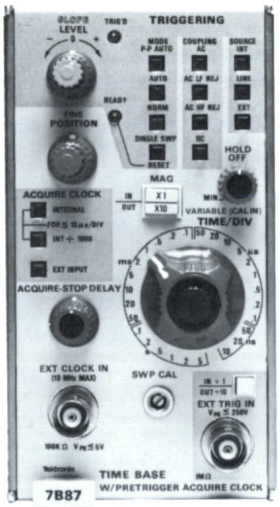
Delayed Time Base

7B85



ΔDelaying Time Base

7B87



Time Base

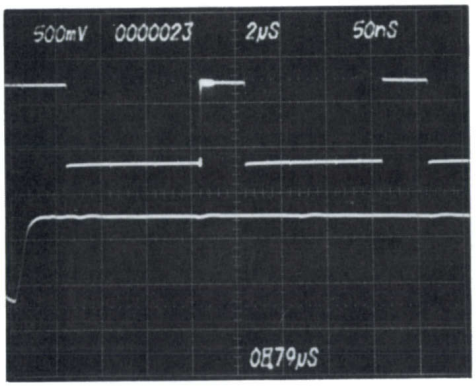


Figure 1. Delaying and delayed sweeps are shown with the mainframe selecting Alt sweep modes. The delay time to the start of the delayed sweep is digitally presented on the lower edge of the CRT.

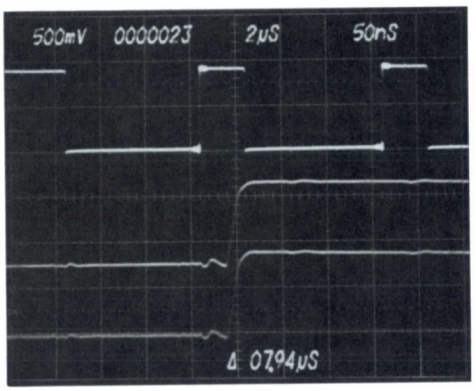


Figure 2. With the mainframe still selecting Alt sweeps, delaying and both delayed sweeps are shown. The digital readout on the lower CRT edge shows the time between the two sweep delays. The Trace Separation knob is used to position the second delayed sweep below the first delayed sweep with up to 3 division of separation.

Sweep Accuracy — Measured over the center 8 divisions, +15°C to +35°C, in the 7700, 7800, or 7900 Series mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div*1	Unmagnified	Magnified
5 s/div to 1 s/div	4%	Unspecified
0.5 s/div to 50 ns/div	1.5%	2.5%
20 ns/div to 10 ns/div	2.5%	4.0%

**1 Fastest calibrated sweep rate is limited by 7700 and 7600.*

Trigger Holdoff Time

Minimum Holdoff Setting	5 s/div to 1 μs/div	2 times Time/Div setting or less
	0.5 μs/div to 10 ns/div	2.0 μs or less
Variable Holdoff Range	Extends holdoff time through at least 2 sweep lengths for rates of 20 ms/div or faster	

ΔTime Range — 0 to at least 9 times Time/Div setting (7B85 only).

ΔTime Accuracy (+15°C to +35°C) — 0.5 s/div to 50 ms/div: Within (0.5% measurement +0.1% full scale +1 least significant digit)*1. 20 ms/div to 100 ns/div: Within (0.5% measurement +0.03% full scale +1 least significant digit)*1 (7B85 only).

Trace Separation Range — Functional only in ΔDelay Time mode when alternating or chopping between time-base units. The second delayed sweep display can be vertically positioned at least 3 division below the first delayed sweep display (7B85 only).

Delay Time — Range: 0.2 or less to at least 9.0 times Time/Div setting. Jitter: 0.02% of Time/Div setting plus 0.1 ns, or less (7B85 only).

**1 Full scale equals 10 times the Time/Div switch setting.*

TRIGGERING

Triggering Sensitivity (Auto and Norm Modes)*1

Coupling	Triggering Frequency Range*2	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	50 mV 250 mV
Ac LF Rej*3	30 kHz to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	50 mV 250 mV
Ac HF Rej	30 Hz to 50 kHz	0.3 div	50 mV
Dc*4	Dc to 50 MHz 50 MH to 400 MHz	0.3 div 1.5 div	50 mV 250 mV

**1 From repetitive signals.*

**2 Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Internal mode.*

**3 Will not trigger on sine waves of less than 8 division Internal, or 3 V External, at or below 60 Hz.*

**4 Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.*

Single Sweep — Requirements are same as for repetitive inputs.

Internal Trigger Jitter — 0.1 ns or less at 400 MHz.

Triggering Sensitivity[*1]

Triggering Frequency Range	Min Signal Required	
	Int	Ext
Low Frequency Response: At least 50 Hz	2.0 div	500 mV
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 400 MHz	1.5 div	375 mV

*[*1] P-P Auto Mode (ac or dc coupling).*

External Trigger Input — Maximum Input Voltage: 250 V (dc + peak ac). Input R and C: 1 MΩ within 5% and 20 pF within 10%. Level Range (Excluding P-P Auto): At least ±1.5 V in Ext ÷ 1, and at least ±15 V in Ext ÷ 10.

Internal Clock — Pretrigger: 0.02048 Hz to 20.45 MHz determined by the Time/Div, X10 magnification and ÷ 1000 switches. Accuracy of Internal and Internal ÷ 1000 = 0.1% (7B87 only).

External Clock — Maximum Input: 5 V peak. Input R: 100 kΩ within 5%. Threshold voltage TTL compatible. Maximum input frequency 10 MHz with BNC input. Delay 0.5 μs or less (7B87 only).

Acquire Stop Delay — Total Range: 0.2 or less to at least 9.9 times Time/Div setting. Jitter (5 s/div to 10 μs/div): 0.02% of Time/Div setting or less. Delay Accuracy (+15°C to +35°C): From 0.5 s/div to 10 μs/div is within 0.5% of measurement plus 5% of Time/Div setting (7B87 only).

Single Shot Performance — Using 7B87 with 7854 Internal Clock (7B87 only).

Fastest Sweep (Time/Div)	Points/Waveform
50 μs	128
100 μs	256
200 μs	512
500 μs	1024

7B80 Option 02, X-Y Phase Shift (Determined by the Circuitry in Mainframe) — For mainframe without X-Y horizontal compensation, the mainframe phase shift specifications are retained for frequencies of 50 kHz and below. For mainframes with optional X-Y horizontal compensation, the extra delay adds to the phase shift error above 50 kHz. For example, a 7904A Option 02 would have 2° of phase shift at 1 MHz and the total phase shift would be 4°.

Included Accessory — Instruction manual.

ORDERING INFORMATION

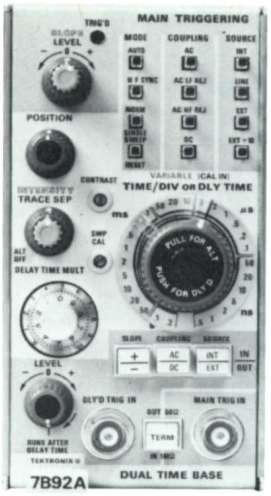
7B80 Time Base **$1,485**

Option 02 — X-Y Horizontal Compensation ..... **+$100**

7B85 Delaying Time Base **$1,700**

7B87 Time Base (for use with 7854) **$1,670**

7B92A



Dual Time Base

7B92A

0.5 ns/div to 0.2 s/div Calibrated Time Base

Triggering to 500 MHz

Alternate Display of Intensified Delaying and Delayed Sweeps

Contrast Regulation Between Delaying and Delayed Sweeps

The 7B92A Dual Time Base is recommended for use only in the 7800 and 7900 Series mainframes. (The 7B92A may be used in all other mainframes at slower sweep speeds.)

There are four display modes: normal sweep, intensified delaying sweep, delayed sweep, and alternate sweep (excepting alternate in R7704). When operating in the Auto mode of main triggering, a bright base line is displayed in the absence of a trigger signal.

CHARACTERISTICS

DELAYING SWEEP (MAIN SWEEP)

Sweep Rate — 0.2 s/div to 10 ns/div in 23 calibrated steps (1-2-5 sequence). An uncalibrated variable rate is continuous between steps, and extends sweep rate to at least 0.5 s/div. The Variable control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy — Measured over the center 8 division in a 7900 Family oscilloscope:

Time/Div	+15°C to +35°C	0°C to +50°C
0.2 s/div to 20 ns/div	Within 2%	Within 3%
10 ns/div	Within 3%	Within 4%

Delay Time Multiplier Range — 0 to 9.8 times the Dly Time/Div setting from 0.2 s/div to 10 ns/div (0 to 1.96 s).

Delay Time Jitter[*1]

0.2 s/div to 50 μs/div	1 part in 50,000 of the maximum available delay time
20 μs/div to 10 ns/div	1 part in 50,000 of the maximum available delay time +0.5 ns

*[*1] Not applicable for the first 2% of maximum available delay time (Delay Time Mult dial setting >0.2). Maximum available delay time is 10 times the Time/Div or Dly Time switch setting.*

Differential Delay Time Measurement Accuracy[*1]

Sweep Speed		
0.2 s/div to 0.1 μs/div	Both Delay Time Mult dial settings at 0.5 or greater	±(0.75% of measurement +0.25% of full scale[*2])
	One or both Delay Time Mult dial settings at less than 0.5	±(0.75% of measurement +0.5% of full scale[*2] +5 ns)
50 ns/div to 10 ns/div	Both delay times equal to or greater than 25 ns	±(1% of measurement +0.5% of full scale[*2])
	One or both delay times less than 25 ns	±(1% of measurement +1% of full scale[*2] +5 ns)

*[*1] +15°C to +35°C.*

*[*2] Full scale is 10 times the Time/Div or Dly Time setting. Accuracy applies over the center 8 Delay Time Multiplier div from +15°C to +35°C.*

MAIN TRIGGERING

Auto, Norm

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV
Ac LF Rej	30 kHz to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mv
Ac HF Rej	30 Hz to 50 kHz	0.5 div	100 mV
Dc	Dc to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV

HF Sync — Triggering sensitivity is 0.5 div Int or 100 mV Ext, from 100 MHz to 500 MHz for any coupling except Ac HF Rej.

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, time base produces one sweep only until reset.

Internal Trigger Jitter — 50 ps or less at 500 MHz.

External Trigger Input — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by ≈20 pF). Maximum safe input is 250 V (dc + peak ac) for 1 MΩ input and 1 W average for 50 Ω input. Range of trigger level is at least ±3.5 V in Ext, and at least ±35 V in Ext ÷ 10.

DELAYED SWEEP

Sweep Rate — 0.2 s/div to 0.5 ns/div in 27 steps (1-2-5 sequence). An uncalibrated variable rate is continuous between steps, and extends sweep rate to at least 0.5 s/div. The Variable control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy — Measured over the center 8 div in a 7900 Family oscilloscope:

Time/Div	+15°C to +35°C	0°C to +50°C
0.2 s/div to 20 ns/div	Within 2%	Within 3%
10 ns/div to 5 ns/div	Within 3%	Within 4%
2 ns/div to 1 ns/div	Within 4%	Within 5%
0.5 ns/div	Within 5%	Within 6%

Delayed Triggering

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV
Dc	Dc to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV

Internal Trigger Jitter — 50 ps or less at 500 MHz.

External Trigger Input — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by ≈20 pF). Maximum Safe Input: 250 V (dc + peak ac) for 1 MΩ input, and 1 W average for 50 Ω input. Range of Trigger Level: At least ±3.5 in Ext.

Included Accessory — Instruction manual.

Order 7B92A Dual Time Base **$3,365**

7B10/7B15

0.2 ns/div to 0.2s/div Calibrated Time Bases

Triggering to 1 GHz

Variable Trigger Holdoff

Peak-to-Peak Autotriggering

7B15 Features:

ΔTime Measurements with CRT Readout

Delayed Time Measurements with CRT Readout

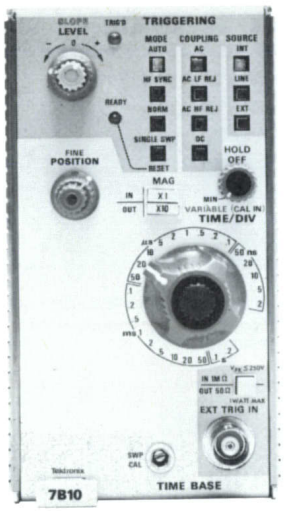
Vertical Trace Separation Between Two Delayed Sweeps

The 7B10 and 7B15 are horizontal time bases designed for use with the 7104 Mainframe to provide optimum bandwidth/sweep speed/compatibility, but may also be used with the 7700, 7800, and 7900 Series mainframes. (Each may be used in any slower 7000 Series mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

The 7B10 and 7B15 or the 7B80 and 7B85 provide the Δtime measurement capability in addition to the standard delay time capability. Either time interval is digitally displayed on the CRT. A single intensified zone, which can be positioned anywhere on the trace, identifies the delay time interval (the time from the "A" or main sweep to the start of the intensified zone). Two intensified zones, which can also be positioned anywhere on a trace, identify the Δtime interval (time between intensified zones). Alternate sweep switching makes it possible to display the information between the intensified zones full screen at the "B" sweep speed. By overlapping the two expanded waveforms, you are confident of the exact positioning of the intensified zones on the "A" sweep. This results in easy-to-make, precise and repeatable timing measurements.

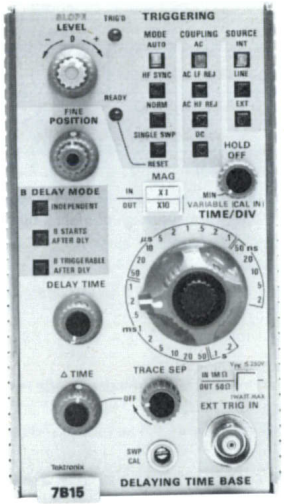
By rotating the Trace Separation control out of the Off position, the Δtime mode is activated. Two intensified zones can be independently positioned. As in the conventional delay mode, the Delay Time knob adjusts the time to the first intensified zone; the ΔTime knob adjusts the time between the two intensified zones. Now, the CRT digital readout shows the Δtime between the two delays.

7B10



Delayed Time Base

7B15



ΔDelaying Time Base

Either plug-in can be used separately as an independent single time base, or they can be combined in any mainframe with two horizontal compartments for delaying and delayed operation.

CHARACTERISTICS

Sweep Rates — 0.2 s/div to 2 ns/div in 25 steps. X10 Magnifier extends fastest calibrated sweep rate to 0.2 ns/div. The uncalibrated Variable is continuous to at least 2.5 times the calibrated sweep.

Sweep Accuracy — Measured over the center 8 div, +15°C to +35°C, in the 7104, 7800 or 7900 Series mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div*1	Unmagnified	Magnified
0.2 s/div to 10 ns/div	2%	3%
5 ns/div and 2 ns/div	3%	4%

**1 Fastest calibrated sweep rate is limited by 7900, 7800, 7700, 7600 and 7300 Series mainframes.*

Trigger Holdoff Time

	Minimum	Maximum with Variable
0.2 s/div to 50 ms/div	40 ms	400 ms
20 ms/div to 2 μs/div	X2 the Time/Div Setting	X20 the Time/Div Setting
1 μs/div to 0.5 μs/div	2 μs	20 μs
0.2 μs/div to 2 ns/div	2 μs	6 μs

ΔTime Range — 0 to at least 9 times Time/Div setting.

ΔTime Accuracy — Within (0.5% measurement plus three least significant digits) 20 ms/div to 100 ns/div.

Trace Separation Range — Functional only in ΔDelay Time mode when alternating or chopping between time base units. The second delayed sweep display can be vertically positioned at least three divisions below the first delayed sweep display.

Delay Time Range — 0.2 or less to at least 9.0 times Time/Div setting.

Jitter — 0.02% of Time/Div setting up through 50 μs/div. 0.03% of Time/Div setting plus 0.1 ns for sweep speeds of 20 μs/div through 100 ns/div.

TRIGGERING

Triggering Sensitivity

Coupling	Triggering Frequency Range*1	Minimum Triggering Signal Required Int	Ext
Ac	30 Hz to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV
Ac LF Rej*2	50 kHz to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mv 150 mV
Ac HF Rej	30 Hz to 40 kHz	0.5 div	50 mV
Dc*3	Dc to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV

**1 The triggering frequency ranges given here are limited to the −3 dB frequency of the oscilloscope vertical system when operating in the Internal mode.*

**2 Will not trigger on sine waves at or below 60 Hz when amplitudes are <8 division Internal or 3 V External.*

**3 The Triggering Frequency Range for Dc Coupling applies to frequencies above 30 Hz when operating in the Auto Triggering Mode.*

Single Sweep — Requirements are the same as for repetitive inputs.

Internal Trigger Jitter — 30 ps or less at 1 GHz.

HF Sync Mode — 250 MHz to 1 GHz 0.3 div internal and 0.75 mV external.

External Trigger Input — Maximum input voltage is 250 V (dc + peak ac) for 1 MΩ input, 1 W average for 50 Ω input. Input R and C for 1 MΩ input is 1 MΩ within 5%, 20 pF within 10%; for 50 Ω input, 50 Ω within 2%. Level range is at least ±3.5 V in Ext ÷ 1.

Included Accessory — Instruction manual.

ORDERING INFORMATION

7B10 Time Base **$2,240**

7B15 Delaying Time Base **$2,535**

7B53A/7B50A

5 ns/div to 5 s/div Calibrated Time Base

Single Sweep Operation

Calibrated Mixed Sweep (7B53A)

Optional TV Sync Separator Triggering (7B53A)

Triggering to 100 MHz (7B53A) and 150 MHz (7B50A)

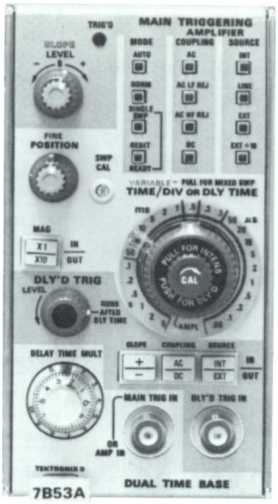
Variable Trigger Holdoff (7B50A)

P-P Auto Triggering (7B50A)

The easy-to-use 7B53A and 7B50A Time Bases are recommended for use with 7600 Series mainframes to provide optimum bandwidth/sweep speed compatibility. They may, however, be used in any 7000 Series mainframe. The fastest rate (5 ns/div) is obtained with the X10 Magnifier.

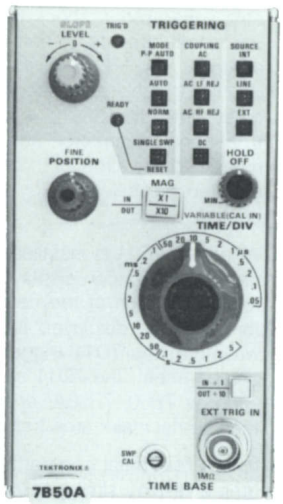
The 7B53A features four kinds of sweep: normal, intensified delaying, delayed, and mixed.

7B53A



Dual Time Base

7B50A



Time Base

CHARACTERISTICS (7B53A)

DELAYING SWEEP

Sweep Rate — 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. The uncalibrated Variable is continuous between steps. The variable control is internally switchable between main, delayed-sweep, and variable main-sweep holdoff.

Sweep Accuracy[*1]

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 1 s/div	3%	4%	Unspecified	Unspecified
0.5 s/div to 0.05 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

*[*1] Measured over the center 8 divisions.*

Delay Time Multiplier Range — 0 to 10 times the Delay Time/Div setting from 5 s/div to 1 μs/div.

Differential Delay Time Measurement Accuracy — 5 s/div to 1 s/div: ±1.4% of measurement +0.3% of full scale. 0.5 s/div to 1 μs/div: ±0.7% of measurement +0.3% of full scale. Full scale is 10 times the Delay Time/Div setting. Accuracy applies over the center 8 DTM div from +15°C to +35°C.

Jitter — 0.05% or less of Time/Div setting.

Triggering Sensitivity

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 10 MHz	0.3 div	100 mV
	10 MHz to 100 MHz	1.5 div	500 mV
Ac LF Rej[*1]	30 kHz to 10 MHz	0.3 div	——
	150 kHz to 10 MHz	——	100 mV
	10 MHz to 100 MHz	1.5 div	500 mV
Ac HF Rej	30 Hz to 50 kHz	0.3 div	100 mV
Dc	Dc to 10 MHz	0.3 div	100 mV
	10 MHz to 100 MHz	1.5 div	500 mV

*[*1] Will not trigger on sinewaves of 3 div or less Int or 1.5 V Ext below 120 Hz.*

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until reset.

Internal Trigger Jitter — 1 ns or less at 75 MHz.

External Trigger Input — Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C: 1 MΩ within 2%, 20 pF within 2 pF. Level Range: At least +1.5 V to −1.5 V in Ext, at least +15 V to −15 V in Ext ÷ 10.

DELAYED SWEEP

Sweep Rate — 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. The uncalibrated Variable is continuous between steps to at least 1.25 s/div and is switchable between the main, delayed sweep, and variable main sweep holdoff.

Sweep Accuracy[*1]

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
0.5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	4%	5%	4.5%	6%
50 ms/div to 0.5 μs/div	3%	4%	3.5%	5%

*[*1] Measured over the center 8 divisions.*

Delayed Sweep Gate — Output Voltage: ≈ +3.5 V into at least 10 kΩ shunted by 100 pF or less, or 0.5 V into 50 Ω. Rise-time: 50 ns or less. Output R is 350 Ω within 10%. Gate is available at the Dly'd Trig In connector when the delayed sweep source switch is set to Int.

Triggering Sensitivity

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 10 MHz	0.3 div	100 mV
	10 MHz to 100 MHz	1.5 div	500 mV
Dc	Dc to 10 MHz	0.3 div	100 mV
	10 MHz to 100 MHz	1.5 div	500 mV

Internal Trigger Jitter — 1 ns or less at 75 MHz.

External Trigger Input — Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C: 1 MΩ within 2%, 20 pF within 2 pF. Level Range: At least +1.5 V to −1.5 V in Ext ÷ 10.

MIXED SWEEP

Sweep Accuracy — Within 2% plus measured main sweep error. Exclude the following portions of mixed sweep: First 0.5 div after start of main sweep display and 0.2 div or 0.1 μs (whichever is greater) after transition of main to delayed sweep.

EXT HORIZONTAL INPUT

Deflection Factor — 10 mV/div within 10% when in Ext, Mag X10; 100 mV/div within 10% when in Ext; 1 V/div within 10% when in Ext ÷ 10.

Bandwidth

Coupling	Lower −3 dB	Upper −3 dB
Ac	40 Hz	2 MHz
Ac LF Rej	16 kHz	2 MHz
Ac HF Rej	40 Hz	100 kHz
Dc	Dc	2 MHz

TV SYNC

Option 05, TV Sync Separator Triggering — Permits stable internal line or field rate triggering from displayed composite video or composite sync waveforms. Conventional waveform displays and measurements can be made from standard broadcast or closed circuit TV systems, domestic or international, with up to 1201-line, 60 Hz field rates. Individual lines may be displayed with delayed sweep features. The wide range of delayed sweeps permits accurate alternate-frame, color-burst observations in the PAL color system. Option 05 deletes ac line trigger and Ext ÷ 10 from trigger source.

Included Accessory — Instruction manual.

CHARACTERISTICS (7B50A)

Sweep Rates — 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. The uncalibrated Variable allows continuous sweep rate selection between steps.

Sweep Accuracy[*1]

Time/Div	Unmagnified	Magnified
5 s/div to 1 s/div	4%	Unspecified
0.5 s/div to 0.5 μs/div	2%	3%
0.2 μs/div to 0.05 μs/div	3%	4%

*[*1] Measured over center 8 div, +15° C to +35° C, with any 7000 Series mainframe. Derate accuracies by an additional 1% each for 0° C to +50° C.*

Trigger Holdoff Time

Minimum Holdoff Setting	5 s/div to 1 μs/div	2 times Time/Div setting or less
	0.5 μs/div to 50 ns/div	2.0 μs or less
Variable Holdoff Range	Extends holdoff time through at least 2 sweep lengths for sweep rates of 20 ms/div or faster	

Triggering Sensitivity[*1]

Coupling	Triggering Frequency Range[*2]	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV
Ac LF Rej[*3]	30 kHz to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV
Ac HF Rej	30 Hz to 50 kHz	0.3 div	50 mV
Dc[*4]	Dc to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV

*[*1] Auto and Norm modes.*
*[*2] Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Int mode.*
*[*3] Will not trigger on sinewaves of <8 div Int, or 3 V Ext, at or below 60 Hz.*
*[*4] Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.*

Triggering Sensitivity[*1]

Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 150 MHz	1.5 div	375 mV

*[*1] P-p Auto Mode ac or dc coupling.*

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until reset.

Option 02, X-Y Phase Shift (Determined by the Circuitry in Mainframe) — For mainframes without X-Y horiz compensation, the mainframe phase shift specification is retained for frequencies of 50 kHz and below. For mainframes with optional X-Y horizontal compensation, the extra delay adds to the phase shift error above 50 kHz.

Included Accessory — Instruction manual.

ORDERING INFORMATION

7B53A Dual Time Base **$1,515**

Option 05 — TV Triggering ..... **+$150**

7B50A Time Base **$945**

Option 02 — X-Y Horizontal Compensation ..... **+$100**

7D11

Digital Delay Unit

7D11

Delay by Time or Events

Digital Delay Readout to 7 1/2 Digits

100 ns to 1 s Delay Time

1 ns Resolution

2.2 ns Delay Time Jitter

0.5 ppm (±2 ns) Accuracy

Delay Interval CRT Display

The 7D11 Digital Delay Plug-in gives stable delayed triggers for measurements requiring low jitter. The 7D11 also provides precision time delays. The 7D11 may be used in any compartment of a 7000 Series mainframe equipped with CRT readout. It provides a variety of outputs.

The delay-by events mode is used to eliminate jitter in mechanically based systems such as disc file memories. It is also useful for selecting a certain time frame in data for analysis and for making other measurements under complex timing conditions.

In the delay-by events, the 7D11 counts arbitrary trigger events, periodic or aperiodic, and delivers an output after the preselected count has been reached (see Figure 2).

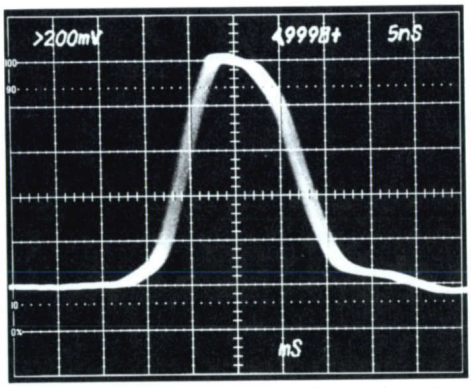


Figure 1. Delay-by-time. A 0.2 µs time marker delayed 4.9998 ms by the 7D11 and displayed at 5 ns/div.

An accurate and jitter-free delay-by-time is very useful when working with digital logic, pcm telemetry, sonar, radar, shock tube testing, and delay line measurements, to name a few. On receipt of a trigger, the 7D11 in the delay-by-time mode counts a highly accurate clock; at the selected delay time, it delivers a delayed trigger to its front-panel connector and mainframe. In both modes, delay time or number of events to be counted is selected by a single front-panel control.

When the 7D11 is installed in a vertical compartment, the CRT can display a waveform that lasts for the duration of the delay interval. This waveform may be displayed together with the signal waveform the 7D11 triggers on. From a vertical compartment, the 7D11 can trigger a time base such as 7B80, 7B53A, or another 7D11 through the internal mainframe trigger path.

In any horizontal compartment, the 7D11 generates a display similar to the "A intensified by B" mode of conventional delayed sweep (see Figure 2). When used in the A horizontal compartment, the 7D11 B sweep delay mode controls will permit the B sweep to run after the delay generated by the 7D11. This delay interval is also available at the front panel for such uses as gated interval counter measurements and generating pulses of highly accurate width.

In delay-by-events, an external pulse (events start trigger) may be used to enable counting of the events. In such applications as a line selector on a video monitor, the vertical sync pulse is the events start trigger. Then the 7D11 counts "n" number of horizontal sync pulses (events) into the field or frame. In a similar manner, the origin pulse of a disc memory can be used as the events start trigger, and the disc clock pulses become the events that are counted.

For timing measurements that require a higher degree of accuracy than the 0.5 ppm source available in the 7D11, the delay-by-time clock may be referenced to an external 1 MHz timing standard through the Ext 1 MHz input.

Time delay resolution up to 1 ns may be obtained by using the front-panel fine delay control.

By setting an internal switch, the indicated delay time is half the actual delay time. In such applications as TDR, radar timing, etc, the CRT readout would display the "one-way-trip" time.

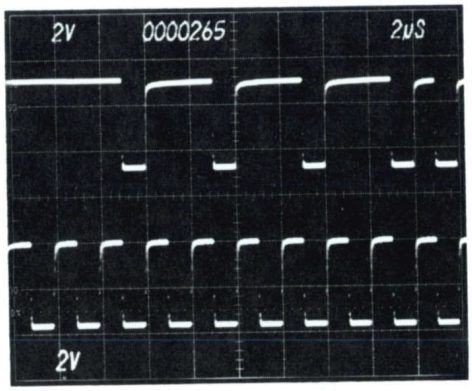


Figure 2. Delay-by events. The lower trace is the master clock in our logic circuit. The top trace is our data which is delayed by 265 clock pulses.

CHARACTERISTICS

EVENTS DELAY

Events Delay Range — One to 10^7 events.
Delay Increment — One event.
Insertion Delay — 35 ns ±5 ns.
Recycle Time — <500 ns.
Maximum Event Frequency — At least 50 MHz.

TRIGGERING

External Trigger

Source	Int, Line, Ext, Ext ÷ 10
Coupling	Dc, Ac, Ac LF Rej, Ac HF Rej
Max Input Voltage	250 V Dc + peak Ac
Level Range	±1.75 V in Ext ±17.5 V in Ext ÷ 10
Input R and C	1 MΩ ±5%, 20 pF ±2 pF

Triggering Sensitivity

Coupling	Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 kHz to 10 MHz 10 MHz to 50 MHz	0.3 div 1.0 div	150 mV 750 mV
Ac LF Rej*1	30 kHz to 10 MHz 150 kHz to 10 MHz 10 MHz to 50 MHz	0.3 div —— 1.0 div	—— 150 mV 750 mV
Ac HF Rej	30 Hz to 50 kHz	0.3 div	150 mV
Dc	Dc to 10 MHz 10 MHz to 50 MHz	0.3 div 1.0 div	150 mV 750 mV

**1 Will not trigger on sinewaves of 3 division or less Int or 1.5 V Ext below 120 Hz.*

Events Start Trigger

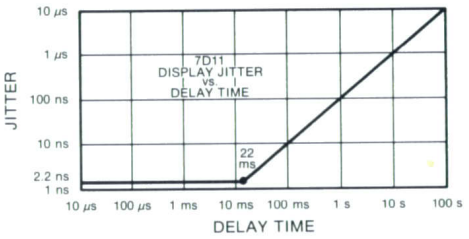
Source	External Only
Coupling	Dc Only
Max Input Voltage	150 V dc + peak ac
Level Range	±3 V
Input R & C	1 MΩ within 5%, 20 pF ±2 pF
Sensitivity	100 mV min, 30 Hz to 2 MHz; increasing to 250 mV, 2 MHz to 20 MHz; increasing to 500 mV, 20 MHz to 50 MHz.

TIME DELAY

Digital Delay Range — Normal Mode: 100 ns to 1 s in 100 ns increments. Echo Mode: 200 ns to 2 s in 200 ns increments.

Analog Delay — Continuously variable from 0 ns to at least 100 ns, accuracy within 2 ns of indicated delay.

Jitter With Internal Clock — 2.2 ns or delay time x 10^{-7}, whichever is greater.



Insertion Delay — Zero within 2 ns.

Recycle Time — Less than 575 ns.

Time Base — 500 MHz oscillator phase-locked to internal or external clock.

Clock — Internal: 5 MHz crystal oscillator. Accuracy is 0.5 ppm. External: 1 MHz within 1%, ac coupled, 50 Ω.

OUTPUTS

Delayed Trigger Out — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Risetime into 50 Ω Load: 2 ns or less. Falltime into 50 Ω Load: 5 ns or less. Pulse Width: 200 ns to 250 ns.

Delay Interval Out — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Risetime Into Falltime: 5 ns or less. Accuracy: Equal to delay interval less 20 ns to 30 ns.

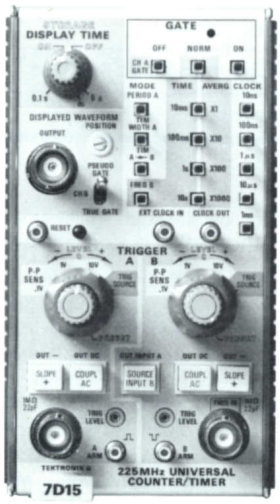
READOUT

Display — 7 1/2 digit with leading zero suppression, ms legend in time delay mode. Plus (+) symbol reminds the operator to add on the Fine Delay (ns) setting.

Included Accessory — Instruction manual.

Order 7D11 Digital Delay Unit **$3,090**

7D15



225 MHz Counter/Timer

7D15

Oscilloscope-Controlled Time and Frequency Measurements

10 ns "Single-Shot" Time Interval Measurement Resolution

Time Interval Averaging

CRT Display of Counting Interval

10 ps Period-Averaging Resolution

Frequency Measurements Directly to 225 MHz

Signal Conditioning via Mainframe Trigger Source

The 7D15 Universal Counter/Timer is designed for use in all 7000 Series oscilloscope mainframes with CRT readout.

The 7D15 can also be completely controlled by the oscilloscope's delayed gate. Arming inputs are provided for each channel. By using the delayed B gate to control the start and stop count points, visually selective measurements can be made at any point on the CRT display.

The 7D15 offers all the measurement capabilities of a Universal Counter/Timer, such as time interval, period, period and time interval averaging, frequency, frequency ratio, totalize, and manual stop watch.

The 7D15 may be used in vertical or horizontal compartments of 7000 Series mainframes. It provides a full eight-digit CRT display with leading zero suppression and positioned decimal. Legend and averaging information appear at the bottom of the CRT display.

Order 42W-5017 for detailed 7D15 Measurement Applications Guide.

Modes of Operation

Frequency Mode	Range	Dc to 225 MHz Resolution 0.1 Hz max
	Accuracy	$\epsilon_{Freq(Hz)} = \pm TB \cdot f_{in} \pm \frac{1}{T}$
Period and Multi-Period Mode	Range	10 ns to 10^5 seconds with averaging times of X1 to X1000 in decade steps. Resolution: 10 picoseconds maximum
	Accuracy	$\epsilon_{period(s)} = \pm TB \cdot P_{in} \pm \frac{10^{-9}}{M} \pm \frac{2E_{npk}}{\frac{dv}{dt} \cdot M} \pm \frac{P_{ck}}{M}$
Time Interval TI and (TI Average) Mode	Range	6 ns to 10 seconds with averaging times of X1 to X1000. 0.1 ns resolution (usable)
	Accuracy Worst Case (Nominal)	$\epsilon_{TI(s)} = \pm TB \cdot P_{in} \pm \frac{P_{ck}}{\sqrt{M}} \pm 10^{-9} \pm \frac{2E_{npk}}{\frac{dv}{dt}}$
Frequency Ratio, CH B/Ext Clock	Range	10^{-7} to 10^4
Manual Stop Watch	Range	0 to 10^5 seconds
Totalize, CH B	Range	0 to 10^8 counts

Note: Formulas given where ϵ is the error; TB (expressed as a decimal) is the time base accuracy; P_{in} is the period of time interval of unknown signal; M is the number of averages given; P_{ck} is the measurement clock period; T is the gate time; f_{in} is the frequency of the unknown signal; E_{npk} equals peak noise pulse amplitude as presented to Schmitt trigger circuit; dv/dt equals signal slope at input to Schmitt trigger (volts per second).

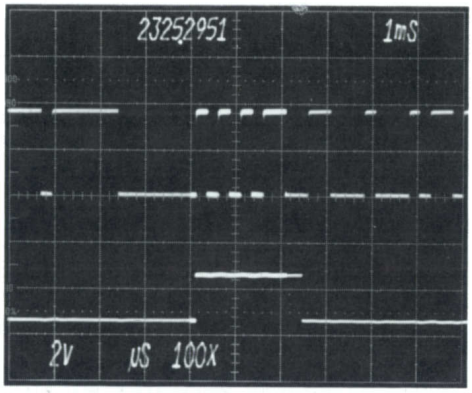


Figure 1. Oscilloscope-controlled digital measurements using the delayed B gate as the arming input logic allow user to make precise time interval measurement from third to seventh pulse on CRT display. Counter CH A is "armed" with leading edge of B gate while CH B Counter is "armed" with falling edge of B gate. Lower trace is pseudo gate of 7D15. CRT readout displays the result of 2325.295 μs.

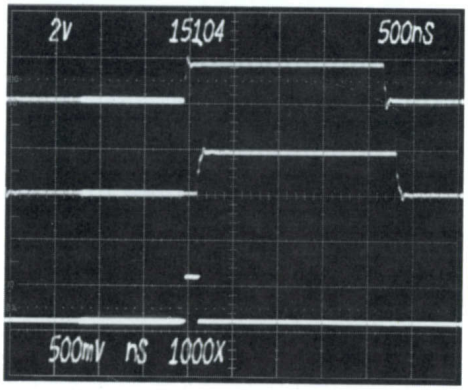


Figure 2. The propagation delay time between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 pseudo gate display. CRT readout displays the result of 151.0 ns.

CHARACTERISTICS

INPUT SIGNAL CH A & B

Frequency Range (CH B Only) — Dc Coupled: Dc to 225 MHz. Ac Coupled: 5 Hz to 225 MHz.

Sensitivity (CH A and B Inputs) — 100 mV p-p. Trigger Source: 0.5 division to 100 MHz, 1.0 division to 225 MHz, or to the vertical system bandwidth, whichever is less.

Input R and C — 1 MΩ and 22 pF.

Triggering (Preset Position) — Automatically triggers at 0 V.

Level Control Range (CH A and B Inputs) — 100 mV Range: ±500 mV. 1-V Range: ±5 V. 10-V Range: ±50 V.

Arming Inputs — Input R and C: 10 kΩ and 20 pF. Sensitivity Arm A: Logical 1 ≥ +0.5 V, logical 0 ≤ +0.2 V. Sensitivity Arm B: Logical 1 ≤ +0.2 V, logical 0 ≥ +0.5 V.

External Clock-In — 20 Hz to 5 MHz.

Reset Front Panel — Reset readies the instrument. All counters are affected, including averaging circuits.

INTERNAL TIME BASE

Crystal Oscillator — Accuracy: Within 0.5 ppm (0°C to +50°C ambient). Long-Term Drift: 1 part or less in 10^7 per month. Oscillator: Temperature compensated; no warm up is required.

OUTPUT SIGNALS

Clock Out — Logical 1 ≥ +0.5 V into 50 Ω. Logical 0 ≤0 V into 50 Ω. TTL compatible without 50 Ω load (1.6 mA current capacity).

A and B Trigger Level — $Z_{out} \approx 1$ kΩ, $V_{out} = \pm 0.5$ V into 1 MΩ.

Displayed Waveform (Internally Connected) — Front-panel switch selects true gate, pseudo gate, or Channel B signal out. Position controlled by front-panel screwdriver control.

External Display — Same as internal except position control has no effect.

Display Mode Switch — 0.1 s to 5 s; also a preset position for infinite display time. Allows selection of readout "follow or store."

Readout — Eight-digit display; the four most significant have zero suppression. Overflow indicated by a greater than symbol.

INCLUDED ACCESSORIES

Two 44 inch Sealectro to BNC connector cables (012-0403-00); instruction manual.

Order 7D15 Universal Counter/Timer **$3,200**

7D12/M2

Oscilloscope-Controlled Sampling DVM

10 ns Aperture Uncertainty

Input Signal and Sample Points Displayed on CRT

1 mV Resolution

25 MHz Bandwidth

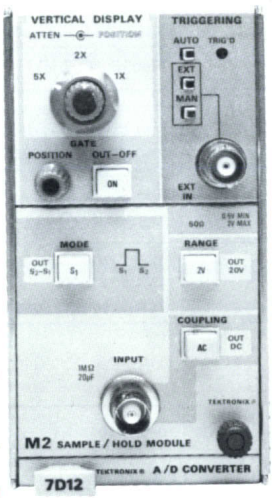
0-to-2 V and 0-to-20 V Input Range, 200 V with P6055 Probe

Automatic, Manual, or External Triggering

Automatic Polarity and Overrange Indicators

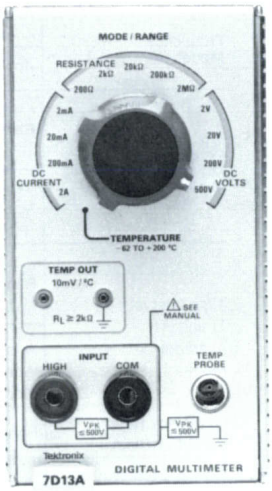
3½ Digit CRT Readout

7D12/M2



A/D Converter and Sample/Hold Module

7D13A



Digital Multimeter

The 7D12 is designed for use with all 7000 Series oscilloscope mainframes with CRT readout.

The M2 Sample/Hold Module measures voltage amplitude from ground to a selected point or the difference voltage between any two selected points (independent control of each point). The sample point(s) may be triggered automatically, manually, or externally from sources such as the oscilloscope's Delayed B gate, the 7D15's pseudo gate, 7D11's delayed trigger out, etc.

On command, the 7D12/M2 samples the displayed waveform and also generates a gate display. Both the signal and 7D12/M2 gate are displayed together, providing a visual indication of where the sample(s) is taken. In the S mode (sample one), a single sample coincident with the rise of the 7D12/M2 displayed gate is taken, and the voltage amplitude, from the 0 V level, is digitally displayed on the CRT readout. In the S_2 - S_1 mode (sample two minus sample one), two samples are taken, one at the rise and one at the fall of the 7D12/M2 displayed gate, and the voltage difference between these two points is digitally displayed on the CRT readout.

CHARACTERISTICS

Sample-Gate Display Amplitude — 2 division, risetime and falltime 5 ns or less.

Analog-Signal Display — Bandwidth is Dc to 25 MHz (dc coupling), 3.4 Hz to 25 MHz (ac coupling). Vertical Sensitivity is 100 mV/div to 5 V/div in 6 steps (1-2-5 sequence in combination with M2 range and 7D12 vertical display attenuation). Accuracy is within 5%.

Input R and C — 1 MΩ and 20 pF.

Maximum Input Voltage — 100 V peak.

Measurement Readout — 0 V to 20 V in two ranges. 3½-digit presentation of 1.999 V and 19.99 V full scale, extended to 199.9 V with P6055 Probe.

Overrange Indication — When overrange occurs, a > symbol appears to the left of the reading.

Aperture Uncertainty — 10 ns or less.

Pulse-Width Sample Time (S_2 − S_1 Mode) — 30 ns to 5 ms with repetitive signal. 150 µs to 5 ms with single-shot signal.

Measurement Rate — External Trigger: 1 to 12 measurements per second, depending on external trigger frequency and internal adjustment. Auto Trigger: 1 to 4 measurements per second, internally adjustable.

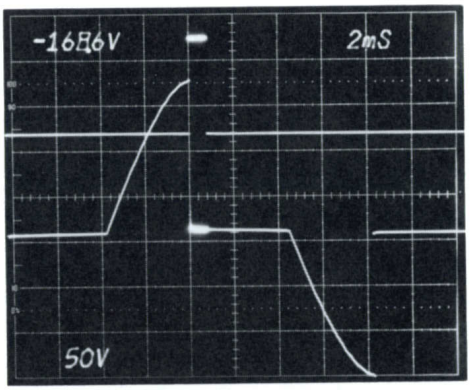
Settling Time — 40 ns.

Accuracy Without Probe[*1]

Temperature Range	S_1 Mode	S_2 − S_1 Mode
+20°C to +30°C	±0.15% of p-p input voltage, ±0.1% of reading, ±2 counts, ± the percentage of ac decay[*2]	±0.25% of p-p input voltage, ±0.15% of reading, ±2 counts, ± the percentage of ac decay[*2]
+15°C to +40°C	±0.25% of p-p input voltage, ±0.2% of reading, ±3 counts, ± the percentage of ac decay[*2]	±0.35% of p-p input voltage, ±0.25% of reading, ±3 counts, ± the percentage of ac decay[*2]

*[*1] 40 ns after Input Signal Step Function.*

*[*2] Applicable when M2 is ac coupled.*



Sample and Hold DVM measures difference voltage (−168.6 V) between two points on complex waveform. Gate waveform indicates two points: leading and trailing edges where voltage difference is made.

Included Accessories — 3.5 ft P6055 Probe package (010-6055-01); instruction manual.

ORDERING INFORMATION

7D12 A/D Converter (Module not included) **$1,625**

M2 Sample/Hold Module **$1,395**

Option 02 — Without P6055 ..... **−$120**

7D13A

Temperature Mode

500 V Maximum Common-Mode Voltage

3½ Digit CRT Readout

The 7D13A Digital Multimeter is designed for use in all 7000 Series oscilloscope mainframes with CRT readout. The 7D13A functions in any compartment.

The 7D13A measures dc volts, dc current, and resistance. It also measures temperature from a temperature sensor on the tip of the P6601 temperature probe. The temperature probe functions regardless of 7D13A mode or range setting and provides a front-panel analog signal output of 10 mV/°C (0°C = 0 V). Temperature may be measured simultaneously along with any other function.

When the 7D13A is used, the character generator traces out a 3½-digit display on the CRT and a legend for units like kΩ, mA, °C.

CHARACTERISTICS

Dc Voltage Range — 0 V to 500 V in four ranges. 3½-digit presentation of 1.999 V, 19.99 V, 199.9 V, and 500 V full scale. Accuracy is ±0.1% of reading ±1 count from +15°C to +35°C, ±0.2% of reading ±2 counts from 0°C to +50°C. Input impedance is 10 MΩ on all ranges. Maximum safe input is 500 V peak between either contact and ground, 500 V peak between voltage contacts.

Dc Current Range — 0 A to 2 A in four ranges. 3½-digit presentation of 1.999 mA, 19.99 mA, 199.9 mA, and 1999 mA full scale. Accuracy is ±0.5% of reading ±2 counts from +15°C to +35°C, ±0.7% of reading ±4 counts from 0°C to +50°C. Maximum input is 3 A (fuse protected).

Resistance Range — 0 MΩ to 2 MΩ in five ranges. 3½-digit presentation 199.9 Ω, 1999 Ω, 19.99 kΩ, 199.9 kΩ, and 1999 kΩ full scale. Accuracy is ±0.5% of reading ±1 count from +15°C to +35°C, ±0.8% of reading ±2 counts from 0°C to +50°C. Input is fuse protected.

Temperature Measurement Range — −62°C to +200°C in one range. 3½-digit presentation to +200°C.

Temperature Measurement Accuracy[*1]

7D13A Operating Conditions	Temperature Value Measured	Measurement Accuracy
+18°C to +28°C (room temperature)	−62°C to +150°C	±2°C
	+150°C to +200°C	0°C, −6°C
0°C to +18°C +28°C to +50°C	−62°C to +200°C	Add 1.5°C to above tolerance in each direction

*[*1] Probe calibrated to the instrument.*

Settling Time — 1 s or less (voltage, current, and resistance modes).

Polarity — Automatic indication.

Maximum Common-Mode Voltage — 500 V peak between two terminals and ground.

Normal-Mode Rejection Ratio — At least 30 dB at 60 Hz.

Common-Mode Rejection Ratio — With a 1 kΩ imbalance, at least 100 dB at dc; 80 dB at 60 Hz.

Over Range Indication — When over range occurs, the readout blinks and the most significant digit displays a three.

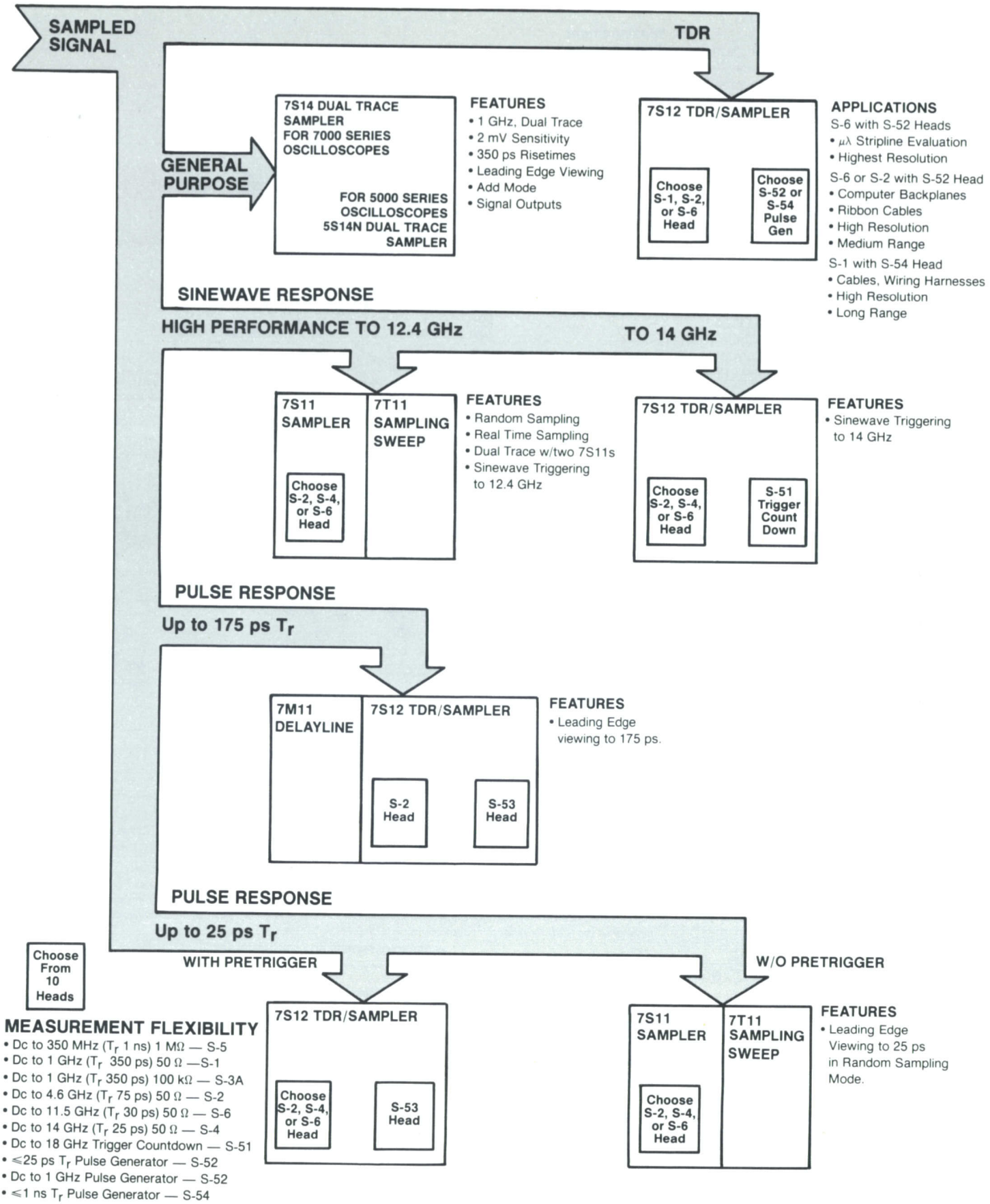
Temperature Out — 10 mV/°C into a load of at least 2 kΩ.

INCLUDED ACCESSORIES

P6601 Temperature Probe package (010-6601-01); pair of test leads (003-0120-00); instruction manual.

Order 7D13A Digital Multimeter **$1,175**

SAMPLING DECISION TREE FOR REPETITIVE SIGNALS



Sampling Plug-ins

7000 Series sampling plug-ins can increase the versatility of your mainframe by providing measurement capabilities up to 14 GHz on repetitive signals. The Sampling family consists of five plug-ins, ten specially-designed sampling heads, and various supporting accessories that provide maximum configurability for the user.

Specific uses for samplers include general UHF measurement and TDR (Time Domain Reflectometry) although other applications are numerous.

For UHF requirements, Tektronix offers flexibility in time domain measurement. For example, the 7S11 Sampling Unit/7T11 Sampling Sweep combination provides triggering to 12.4 GHz, and the choice of modular heads for optimum signal acquisition. Two 7S11s and one 7T11 provide dual-trace capability. For users who want a plug-in sampler operationally similar to conventional vertical/time base plug-ins, the 1 GHz 7S14 is available. Two identical channels provide 2 mV/div sensitivity, dual trace display, built-in time base, and calibrated delayed sweep. All of these plug-ins provide a cost-effective way to obtain Gigahertz measurement capability for repetitive signals.

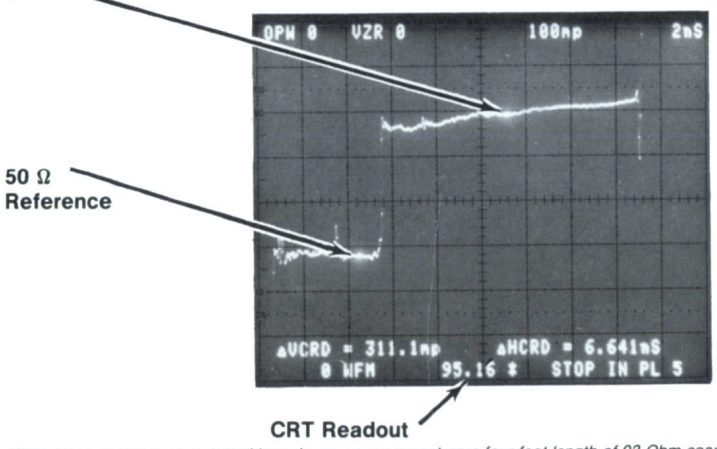
TDR is widely used in microwave stripline evaluation, computer backplane measurements, and printed circuit board testing. The fast risetimes of samplers make them well suited for these measurements. With TDR, a pulse is sent down a conductive path and measured as it reflects back from any impedance changes in the device under test. Any impedance variations in the path cause a corresponding signal to be displayed on the scope. The precise location and type of impedance anomaly (open, short, step change) in the conductive path is directly readable on the display. The 7S12 TDR Sampler is a high-resolution unit that provides maximum versatility for TDR measurements in addition to general purpose applications.

The Sampling Decision Tree diagram can be helpful to select a configuration for a particular measurement requirement.

SAMPLING HEAD CHARACTERISTICS

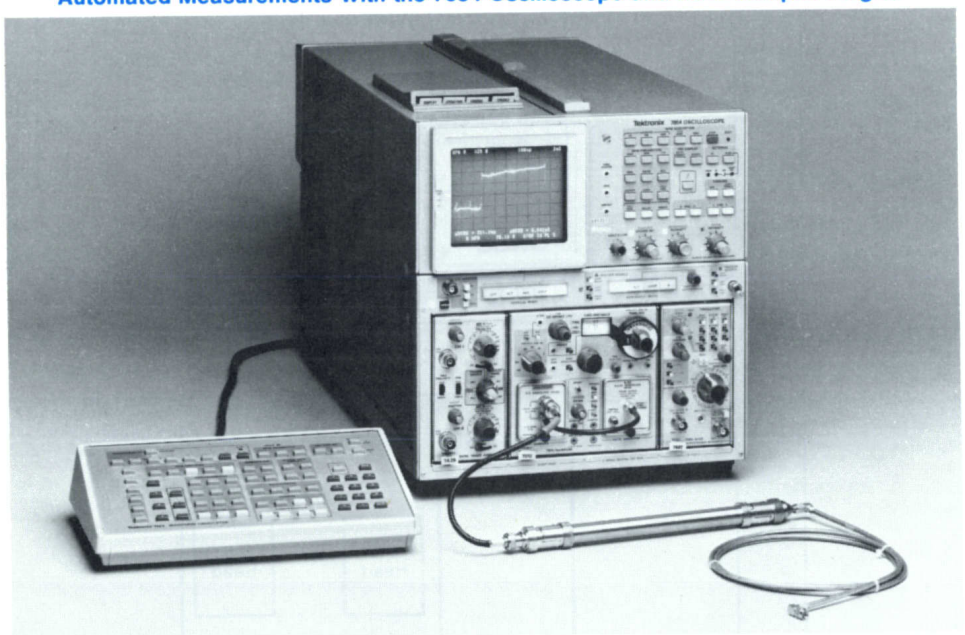
	Bandwidth	Risetime	Input Impedance	Noise	Connector
S-1	Dc to 1 GHz	≤350 ps	50 Ω	≤1 mV*1 ≤2 mV*2	GR
S-2	Dc to 4.6 GHz	≤75 ps	50 Ω	≤3 mV*1 ≤6 mV*2	GR
S-3A	Dc to 1 GHz	≤350 ps	100 kΩ	— ≤3 mV at probe tip*2	Probe
S-4	Dc to 14 GHz	≤25 ps	50 Ω	≤2.5mV*1 ≤5 mV*2	SMA (3 mm)
S-5	Dc to 350 MHz	≤1 ns	1 MΩ	≤500 μV*1 ≤5 mV*2	BNC
S-6	Dc to 11.5 GHz	≤30 ps	50 Ω feed thru	— ≤5 mV*2	SMA (3 mm) (3 mm)

*1 Smoothed
*2 Unsmoothed



CRT photo shows an automated impedance measurement on a four foot length of 93 Ohm coax. An easy-to-use program allows the operator to obtain a direct readout in Ohms (bottom center) after positioning cursors on selected points on the display.

Automated Measurements With the 7854 Oscilloscope and 7S12 Sampler Plug-in



The 7854/7S12 combination is ideally suited for making a wide variety of automated sampling measurements. Examples of easy-to-program measurements are: measuring propagation delay through active or passive devices; measuring distance to faults in coax cables; and measuring impedance in EC boards and other controlled-impedance devices. Programs can be entered into the 7854 via the calculator keyboard for simple operator-controlled measurements, or tests can be computer-controlled via a remote terminal on the GPIB for production applications.

ACCESSORY PROBES FOR 50 Ω SAMPLERS

Type	Attenuation	Length*1	Loading		Risetime in ns	Bandwidth	Package Number*2
Passive							
P6056	10X	6.0	500 Ω	1 pF	<0.1	Dc to 3.5 GHz	010-6056-03
P6057	100X	6.0	5k Ω	1 pF	<0.25	Dc to 1.4 GHz	010-6057-03
Active — FET*3							
P6201	1X	6.0	100 kΩ	3 pF	<0.4	Dc to 900 MHz	010-6201-01 (includes attenuators)
	10X	6.0	1 MΩ	1.5 pF	<0.4	Dc to 900 MHz	
	100X	6.0	1 MΩ	1.5 pF	<0.4	Dc to 900 MHz	
P6202A	10X	2 M	10 MΩ	2 pF	<0.7	Dc to 500 MHz	010-6202-03 plus 010-0384-00 to provide 100X
	100X	2 M	10 MΩ	2 pF	<0.7	Dc to 500 MHz	
Active — Variable Bias/Offset							
P6230	10X	1.6	450 Ω	1.6 pF	≤0.23 ps	Dc to 1.5 GHz	010-6230-01

*1 Length in feet except where specified.
*2 Refer to probe section for additional information.
*3 Requires power source: Most four compartment mainframes provide probe power. See page 437 for FET Probe Power Supplies.

7S12

45 ps TDR or a General Purpose Sampler

6 Plug-In Sampling Heads Available

2 Plug-In Pulse Sources Available

1 Trigger Recognizer Head Available

1 Trigger Countdown Head Available

The 7S12 is a combined vertical-horizontal, double-width plug-in for high resolution TDR or general purpose sampling measurements. As a TDR using the S-6 Sampling Head and S-52 Pulse Generator Head, the 7S12 has a system risetime of 45 ps (return from short-circuit termination) and distance range to 250 feet in any cable. Its vertical scale is calibrated in reflection coefficient (ρ) from 2 mρ/div to 500 mρ/div and in voltage from 2 mV/div to 500 mV/div. Two-way time or one-way distance to a discontinuity of interest is read directly from tape dial calibrated for time, air, polyethylene, or your choice of dielectrics. As a long line TDR using the S-5 Sampling Head and S-54 Pulse Generator Head, distance calibration extends to 4900 feet (air line) and discontinuities to twice this distance may be viewed. System risetime with this combination is 1.5 ns.

General-purpose measurements may be made by using an S-1, S-2, S-3A, S-4, S-5, or S-6 Sampling Head with an S-53 Trigger Recognizer Head or S-51 Trigger Countdown Head. For dual-trace sampling displays, use a 7S11 Sampling Unit with a 7S12. The addition of a 7M11 Dual Delay Line provides the signal delay necessary to view the triggering event when a pretrigger signal is not available.

CHARACTERISTICS

SYSTEM PERFORMANCE WITH S-6 AND S-52

System Risetime — 35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 1 ns test line.

Time and Distance Ranges — Direct-reading tape dial gives calibrated one-way distance to at least 375 ft (air line). Time range is at least 0.75 μs round trip. Both ranges are limited by the duration of the pulse from the S-52.

Pulse Amplitude — At least +200 mV into 50 Ω.

Input Characteristics — Nominal 50 Ω, feed-through signal channel (termination supplied). SMA (3 mm) connectors.

Jitter — <10 ps (without signal averaging).

Aberrations — +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

TDR SYSTEM PERFORMANCE WITH S-5 AND S-54

System Risetime — 1.5 ns or less for the displayed reflection from a short-circuited test line.

Time and Distance Ranges — Direct-reading tape dial gives calibrated one-way distances to 4900 ft air line, 3240 ft solid polyethylene. Time range is 20 μs round trip.

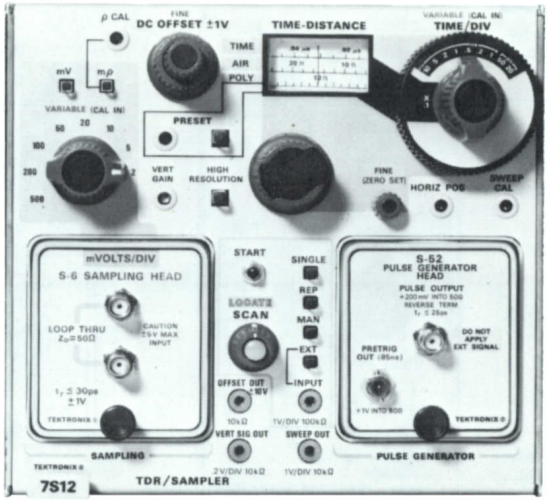
Pulse Amplitude — At least +400 mV into 50 Ω.

Input Characteristics — Nominal 50 Ω test line connection (cable and T supplied). BNC connectors.

Jitter — <20 ps (without signal averaging).

Aberrations — +4%, −6%, total of 10% p-p within first 17 ns of step; +1.5%, −1.5%, total of 3% thereafter.

7S12



TDR/Sampler

OTHER 7S12 CHARACTERISTICS

Vertical Scale — Calibrated in mρ (reflection coefficient 10^{-3}) and mV from 2 to 500 units/div in 8 steps (1-2-5 sequence), accurate within 3%. Uncalibrated Variable is continuous between steps.

Resolution — Reflection coefficients as low as 0.001 may be observed. Signal averaging reduces test-line noise in display.

Dc Offset Range — +1 V to −1 V. Allows open-circuit reflections to be displayed at full sensitivity. Monitor jack provides X10 dc offset through 10 kΩ.

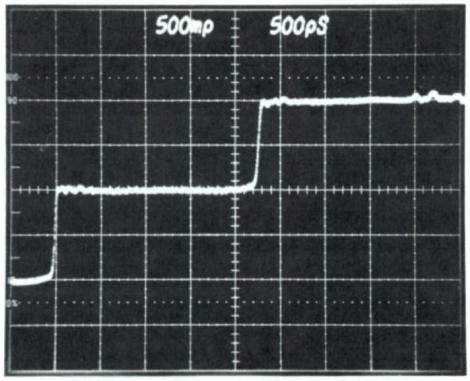
Time/Distance — Tape Dial is Calibrated in Time and Distance: Full-scale ranges of 4900 ft, 490 ft, 49 ft (air dielectric); 3200 ft, 320 ft, 32 ft (polyethylene dielectric); and 10 μs, 1 μs, 0.1 μs (time). Accurate within 1%. Distance calibration may be preset for dielectric having propagation factors from 0.6 to 1.

Time/Div — 20 ps/div to 1 μs/div (1-2-5 sequence) in three ranges with direct-reading magnifier. Accurate within 3%. Uncalibrated Variable is continuous between steps.

Locate Button — Provides instant return to unmagnified display showing entire full-scale range. Brightened portion of trace indicates time position and duration of magnified display.

Display Modes — Repetitive or single sweep, manual or external scan.

Signal Outputs — Pin jacks provide both vertical signal and sweep outputs.



The 7S12 displays reflection coefficient (ρ) versus distance on a device-under-test. Here the 7S12 measures a reflection caused by a crack (open) in a PCB under test. Distance can be read directly from the 7S12 front panel, or calculated from the time base settings.

INCLUDED ACCESSORIES

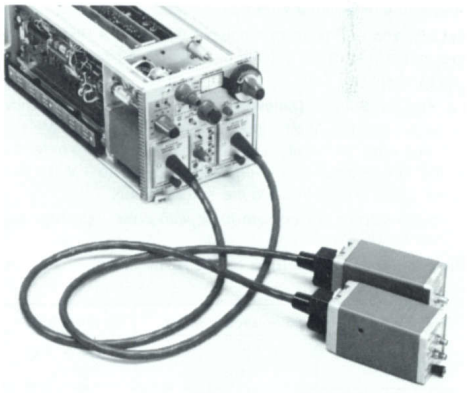
750 ps rigid "U" delay line (015-1017-01); short-circuit termination (015-1021-00); TDR slide rule (003-0700-00); TDR graticule overlay (331-0296-00); TDR graticule overlay (331-0297-00); instruction manual.

ORDERING INFORMATION

7S12 TDR/Sampler without Sampling Heads (Tape Dial in Feet) **$3,595**

Option 03 — Tape Dial Change (Meters) ..... **+$25**

7603 Mainframe **$2,865**



Extenders allow the user to locate the sampling head directly in a test fixture, avoiding potential signal degradation by cables.

OPTIONAL ACCESSORIES

3 ft Sampling-Head Extender — Order 012-0124-00 .. **$375**

6 ft Sampling-Head Extender — Order 012-0125-00 .. **$445**

NOTE: See 1502 and 1503 Portable TDR Cable Testers on pages 150-151.

7T11

10 ps/div to 5 ms/div Calibrated Time Base

Random or Sequential Sampling

Equivalent or Real Time Sampling

No Pretrigger Required

The 7T11 Sampling Time Base provides equivalent-time and real-time horizontal deflection for single- or dual-trace sampling. Timing accuracy is within 3% and nonlinearity is well below 1%. Triggering range is from approximately 10 Hz (sequential mode) to above 12.4 GHz. The 7T11 is a companion unit to the 7S11.

CHARACTERISTICS

Time/Div Range — 10 ps/div to 5 ms/div (1-2-5 sequence) directly related to time position ranges. Uncalibrated Variable is continuous between steps to at least 4 ps/div.

Time Position Range — Equivalent time is 50 ns to 50 μs in four steps; real time is 0.5 ms to 50 ms in three steps.

Time/Div Accuracy — Within 3% for all time/div settings over center 8 cm.

TRIGGERING

Ext 50 Ω Input — Frequency range is dc to 1 GHz in 1X Trig Amp mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 1 GHz) in X1 Trig Amp, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 Trig Amp. Input R is 50 Ω within 10%. Maximum input voltage is 2 V (dc + peak ac).

Ext 1 MΩ Input — Frequency range is dc to 100 MHz in X1 Trig Amp mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 100 MHz) in X1 Trig Amp, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 Trig Amp. Input R is 1 MΩ within 5%. Maximum input voltage is 100 V p-p to 1 kHz (derating 6 dB per octave to a minimum 5 V p-p).

Ext HF Sync — Frequency range is 1 GHz to 12.4 GHz. Sensitivity range is 10 mV to 500 mV p-p. Input R is 1 MΩ. Maximum input voltage is 2 V p-p.

Int Trigger Source (Sinewave Triggering)*[1] — Frequency range is 5 kHz to 500 MHz in X1 Trig Amp; 5 kHz to 50 MHz in X10 Trig Amp. Sensitivity range is 125 mV to 1 V p-p (referred to the vertical input) in X1 Trig Amp; 12.5 mV to 1 V p-p (referred to the vertical input) in the X10 Trig Amp.

*[1] *Trigger circuits will operate to dc with pulse triggering, except for HF Sync.*

Random Mode Trigger Rate — 100 Hz minimum.

Display Jitter*[1]

Time Pos Range	Sequential Mode	Random Mode
50 μs to 500 ns	0.4 div or less	1 div or less
50 ns	10 ps	30 ps

*[1] *Measured under optimum trigger conditions with Time/Div switch clockwise.*

Pulse Out — Positive pulse amplitude at least 400 mV (into 50 Ω) with 2.5 ns risetime or less.

Trigger Kickout — 2 mV or less into 50 Ω (except HF SYNC).

Display Scan Rate — Continuously selectable from at least 40 sweeps/s to <2 sweeps/s.

External Scan — Deflection factor is continuously variable from 1 V/div to 10 V/div. Input R is 100 kΩ within 10%. Maximum input voltage is 100 V (dc + peak ac).

Sweep Out — 1 V/div within 2%. Source R is 10 kΩ within 1%.

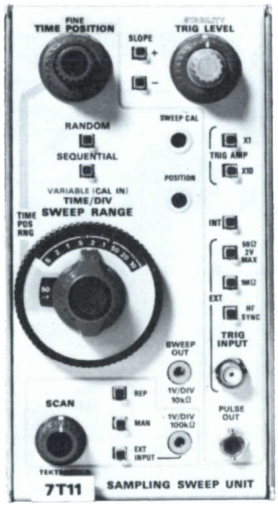
Ambient Temperature — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

INCLUDED ACCESSORIES

42 in BNC 50 Ω cable (012-0057-01); 3 mm SMA male to BNC adaptor (015-1018-00); 10X 50 Ω attenuator (011-0059-02); 3 mm SMA male to GR874 adaptor (015-1007-00); instruction manual.

Order 7T11 Sampling Sweep Unit **$4,730**

7T11

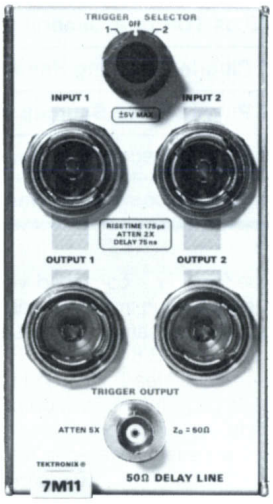


Sampling Sweep Unit

7S11

Sampling Unit

7M11



Delay Line

7S11

2 mV/div to 200 mV/div Calibrated Deflection Factors

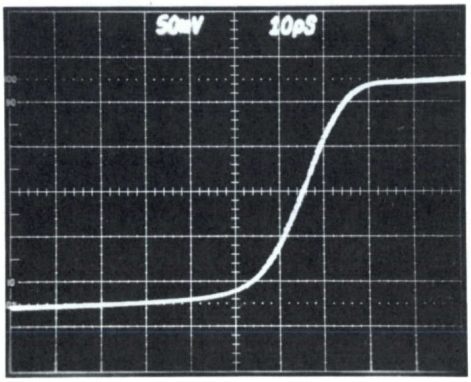
Plug-in Sampling Heads

The 7S11 is a single-channel sampling unit. The input configuration employs the sampling plug-in head concept. The heads, which mount in the 7S11, range in bandwidth from 350 MHz to 14 GHz.

The 7S11 can be used in a variety of combinations. Single-channel sampling uses one 7S11 with a 7T11 Time Base. Two 7S11s and one 7T11 provide dual-trace sampling. One 7S11 and one 7S12 provide dual-trace sampling. Two 7S11s can be used for X-Y operations.

CHARACTERISTICS

Deflection Factor — 2 mV/div to 200 mV/div in 7 steps (1-2-5 sequence), accurate within 3%. Uncalibrated Variable is continuous (extends deflection factor from 1 mV/div or less to at least 400 mV/div). Deflection factor is determined by the plug-in sampling head.
Bandwidth — Determined by the sampling head.
Input Impedance — Determined by the sampling head.
Dc Offset — Range, +1 V to −1 V or more. Offset out is 10X the offset voltage within 2%. Source R is 10 kΩ within 1%.
Delay Range — At least 10 ns for comparing two signals in a dual-trace application.
Memory Slash — 0.1 division or less at 20 Hz.
Vertical Signal Out — 200 mV per displayed div within 3%.
Ambient Temperature — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.
Included Accessory — Instruction manual.



7S11 and 7T11 Plug-ins together provide accurate measurements on repetitive signals. Pulse risetime of 21 ps shown.

Order 7S11 Sampling Unit without Sampling Head **$1,885**

7M11

75 ns Time Delay

Selectable Trigger Out

175 ps Risetime

The 7M11 is a passive dual delay line for use with the 7000 Series Sampling System. In low-repetition-rate applications requiring the sequential mode of operation, the 7M11 provides the trigger source and signal delay necessary to view the triggering event at fast time-per-division settings.

Vertical delay for two 7S11 vertical sampling units is available with the dual 50 Ω, 75 ns delay lines. The closely matched (30 ps) lines have GR874 input-output connectors, 175 ps risetime, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a risetime of 600 ps or less.

CHARACTERISTICS

DELAY LINE

Time Delay — 75 ns within 1 ns.

Delay Difference — 30 ps or less between channels.

Risetime — 175 ps or less.

Attenuation — 2X within 2% into 50 Ω.

Input Impedance — 50 Ω within 2%.

Maximum Input — ±5 V (dc + peak ac).

TRIGGER OUTPUT

Risetime — 600 ps or less.

Attenuation — 5X within 10% into 50 Ω (referred to Input).

Output Impedance — 50 Ω within 10%.

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

INCLUDED ACCESSORIES

Ten inch BNC cable (012-0208-00); two 2 ns GR cables (017-0505-00); instruction manual.

Order 7M11 Delay Line **$1,415**

7S14/5S14N

Calibrated Delayed Sweep

Two-Dot Measurements

Dc to 1 GHz Bandwidth

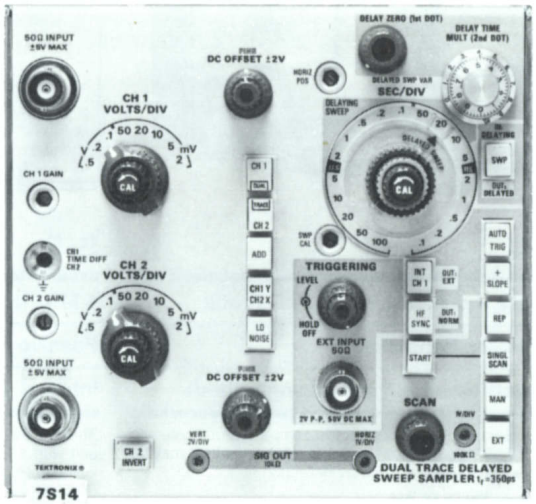
Dual Trace, 2 mV Sensitivity

CRT Readout (7S14 Only)

Simplified Triggering

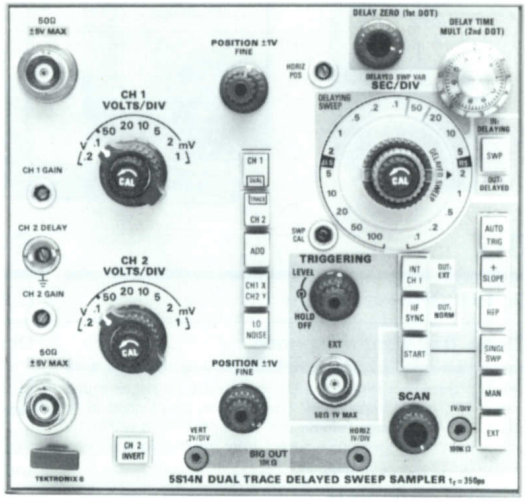
Operational Ease of a Conventional Oscilloscope

7S14



Dual Trace Delayed Sweep Sampler

5S14N



Dual Trace Delayed Sweep Sampler

The 7S14 Sampling Unit combines vertical and time-base functions in one double-width plug-in. Two identical vertical channels provide dual-trace sampling, a two-ramp time base and calibrated delayed sweep. Front-panel controls are grouped by color, and the control nomenclature is similar to conventional oscilloscope nomenclature. Learning to operate the 7S14 requires a minimum of effort for those familiar with conventional oscilloscope operation for 7000 Series.

A unique feature is a system for making two-dot time-interval measurements. This feature provides an easy and accurate means for measuring the time between two points on a waveform. One bright dot on the trace is positioned with the Delay Zero control to the start of an event to be measured. Next a second bright dot is positioned by the Delay Time Multiplier Control to the end of the event. The time-interval between the selected points is then determined by multiplying the number read directly from the Delay Time Multiplier Dial by the selected time per division.

The 5S14N Sampling Unit combines amplifier and time-base functions in one double-wide plug-in unit designed to operate in all 5000 Series mainframes. Combining the sampling amplifier and time-base functions in one plug-in enables the 5S14N to provide economy and ease of operation. There is no readout with the 5S14N.

CHARACTERISTICS

The following specifications are identical for both units unless otherwise noted.

VERTICAL CHANNEL

Modes — CH 1 only; CH 2 only; Dual Trace; CH 1 added to CH 2; CH 2 subtracted from CH 1 (CH 2 Invert); CH 1 Vertical (Y), CH 2 Horizontal (X).

Input Impedance — Nominally 50 Ω.

Bandwidth — Equivalent to dc to 1 GHz.

Risetime — 350 ps or less.

Step Aberrations — +2%, −3%, total of 5% p-p within first 5 ns, ±1% thereafter, both tested with a 284 Pulse Generator.

Deflection Factor — 2 mV/div to 0.5 V/div in 8 steps (1-2-5 sequence). Continuously variable between steps by at least 2.5 to 1.

Accuracy — Within ±3%.

Maximum Input Voltage — ±5 V.

Input Signal Range — 2 V p-p maximum within a +2 V to −2 V window at any sensitivity.

Dc Offset Range — At least +2 V to −2 V.

Displayed Noise — 2 mV or less unsmoothed (measured tangentially). Low noise pushbutton reduces random noise by a factor of 4 to 1 or more.

Vertical Signal Output — 0.2 V/div of vertical deflection; 10 kΩ source resistance.

Channel Delay Difference — Adjustable to zero, or for any time difference up to at least 1 ns.

TIME BASE

Scan Modes — Repetitive, single, manual, or external.

Delaying Sweep — May be used as the CRT time base or as a delay generator for the delayed sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the delaying sweep mode is selected for the time base, two bright dots in the trace, which may be positioned anywhere on the displayed waveform, are generated. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the Time/Div.

Delayed Sweep — This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per division. The delayed sweep may be started with zero delay time with respect to the start of the delaying sweep. Or the start may be delayed by any time interval up to that represented by 10 divisions of the delaying sweep selected.

Horizontal Signal Output — 1.0 V/div of horizontal deflection; 10 kΩ source resistance.

DELAYING SWEEP

Range — 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).

Accuracy — Within ±3%, excluding first 0.5 division of displayed sweep.

Delayed Zero (1st Dot) — Adjustable to correspond to any instant within the time interval represented by the first 9 division of the delaying sweep selected.

Delay Time (2nd Dot) — Adjustable to any position of the time interval represented by 10 division of the delaying sweep selected.

Delay Accuracy — Within ±1% of 10 division when measurement is made within the last 9.5 division.

DELAYED SWEEP

Range — 100 ps/div to 100 μs/div in 19 steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy — Within ±3% excluding first 0.5 division of displayed sweep.

Start Delay — Depends on the delaying sweep time selected and the setting of the Delay Time Multiplier dial. Adjustable from zero to any time interval up to that represented by 10 divisions of the delaying sweep selected. The delaying sweep start point corresponds to the position of the second bright dot.

Delay Jitter — <0.05% of the time represented by 1 division of the delaying sweep selected.

TRIGGERING AND SYNC

Signal Sources — Internal from CH 1 vertical input or external through front-panel connector.

External Triggering — Nominal 50 Ω input, ac coupled, 2 V p-p 50 V dc maximum. Trigger pulse amplitude 10 mV p-p or more with risetime of 1 μs or less. 10 Hz to 100 MHz. Sinewave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

Internal Triggering — Pulse amplitude 50 mV p-p or more with risetime of 1 μs or less. Sinewave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

Triggered Mode — Trigger recognition may be made to occur at any selected voltage level between +0.5 V and −0.5 V on either a + slope or a − slope of the triggering signal.

Autotrigger Mode — For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so that a trace may always be generated and displayed. The trigger level range automatically adjusts to approximately the p-p voltage of the signal.

Holdoff — Varies the length of the interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

HF SYNC Mode — For sinewaves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

INCLUDED ACCESSORIES

Two X10 attenuators (011-0059-02); two 42 in 50 Ω coaxial cables (012-0057-01); instruction manual.

ORDERING INFORMATION

7S14 Dual-Trace Delayed Sweep Sampler for 7000 Series Oscilloscopes **$5,555**

5S14N Dual-Trace Delayed Sweep Sampler for 5000 Series Oscilloscopes **$5,630**

S-1

Dc to 1 GHz Bandwidth

Clean Transient Response

The S-1 Sampling Head is a low noise, 350 ps risetime unit with a 50 Ω input impedance. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-1 provides a trigger signal output from the plug-in unit.

Risetime — 350 ps or less.

Bandwidth — Equivalent to dc to 1 GHz at 3 dB down.

Transient Response — Aberrations as observed with the 284 Pulse Generator are +0.5%, −3% or less, total of 3.5% or less p-p, first 5 ns following the step transition; −0.5% or less, total of 1% or less p-p after 5 ns.

Displayed Noise — 2 mV or less, unsmoothed; 1 mV, smoothed.

Signal Range — Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be <500 mV p-p.

Input Characteristics — Norminally 50 Ω. Safe overload in ±5 V. GR874 input connectors.

Included Accessories — 5 ns, 50 Ω RG58 A/U Cable (017-0512-00); 10X, 50 Ω GR attenuator (017-0078-00); instruction manual.

Weight — Net: 0.5 kg (1.0 lb). Shipping: 1.4 kg (3.0 lb).

Order S-1 Sampling Head **$1,230**

S-2

Dc to 4.6 GHz Bandwidth

Displayed Noise <6 mV (Unsmoothed)

The S-2 Sampling Head is a 75 ps risetime unit with a 50 Ω input impedance. The S-2 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-2 provides a trigger signal output from the plug-in unit.

Risetime — 75 ps or less.

Bandwidth — Equivalent to dc to 4.6 GHz at 3 dB down.

Transient Response — Aberrations as observed with the 284 Pulse Generator are +5%, −5% or less, total of 10% or less p-p, first 2.5 ns following a step transition; +2%, −2% or less total of 4% or less p-p after 2.5 ns.

Displayed Noise — 6 mV or less, unsmoothed; 3 mV, smoothed.

Signal Range — Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be <200 mV p-p.

Input Characteristics — Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

Included Accessories — 5 ns, 50 Ω RG213/U Cable (017-0502-00); 10X, 50 Ω GR attenuator (017-0078-00); instruction manual..

Weight — Net: 0.5 kg (1.0 lb). Shipping: 1.4 kg (3.0 lb).

Order S-2 Sampling Head **$1,445**

S-3A

Compact, 4.5 ft, 100 kΩ, 2.3 pF Probe

Dc to 1 GHz Bandwidth

Displayed Noise <3 mV (Unsmoothed)

The S-3A Sampling Head is an active sampling-probe unit with 100 kΩ, 2.3 pF input impedance. Up to 2 V of dc offset may be used while maintaining a 2 mV/div deflection factor.

Risetime — 350 ps or less.

Bandwidth (Probe Only) — Equivalent to dc to 1 GHz at 3 dB down.

Transient Response (Probe Only) — Aberrations in the first 2 ns following a step are +8%, −2% or less, total of 10% or less p-p, +1%, −1% or less, total of 2% or less p-p after 2 ns, with 284 pulse displayed.

Displayed Noise (Probe Only) — 3 mV or less referred to probe tip (includes 90% of dots).

Signal Range — Variable dc offset allows signals between +1 V, 1X range, or +2 V and −2 V, 2X range, to be displayed at 2 mV/div. The signal range may be increased 10X or 100X with the probe attenuators.

Included Accessories — 10X attenuator head (010-0364-00); 100X attenuator head (010-0365-00); two test-point jacks (131-0258-00); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip ground adaptor (013-0085-00); 5 1/2 inch ground lead (175-1017-00); 12 1/2 inch ground lead (175-1018-00); 3 inch cable assembly (175-0249-00); end cap (200-0834-00); three ground clips (344-0046-00); two end caps (200-0835-00); probe holder (352-0090-00); carrying case (016-0121-01); 6 inch elec lead (175-0849-00); 3 inch elec lead (175-0849-00); retractable hook tip (013-0097-01); 50 Ω voltage pickoff (017-0077-01); instruction manual.

Weight — Net: 1.4 kg (3.0 lb). Shipping: 2.3 kg (5.0 lb).

Order S-3A Sampling Head **$1,885**

S-4

25 ps Sampling Head

Dc to 14 GHz Equivalent Bandwidth

Displayed Noise <5 mV (Unsmoothed)

The S-4 Sampling Head is a 25 ps risetime unit with a 50 Ω input impedance. The S-4 can be plugged into the sampling unit or attached by a sampling head extender for remote use. A trigger pickoff within the S-4 provides a trigger signal output from the plug-in unit.

Risetime — 25 ps or less.

Bandwidth — Equivalent to dc to 14 GHz at 3 dB down.

Transient Response — Aberrations in the first 400 ps following a step from an S-52 Pulse Generator Head are −10%, +10% or less, total of 20% or less p-p. From 400 ps to 25 ns following a step from a 284 Pulse Generator, −0%, +10% or less, total of 10% or less, p-p with 284 pulse displayed; after 25 ns, −2%, +2% or less, total of 4% or less p-p.

Displayed Noise — 5 mV or less, unsmoothed; 2.5 mV, smoothed (includes 90% of dots).

Signal Range — Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 500 mV p-p.

Input Characteristics — Nominally 50 Ω. Safe overload ±5 V. SMA (3 mm) input connector.

Included Accessories — 2 ns cable with SMA connectors (015-1005-00); 10X 50 Ω SMA attenuator (015-1003-00); GR874 to SMA male adaptor (015-1007-00); SMA male-to-male adaptor (015-1011-00); 5/16 inch wrench (003-0247-00); instruction manual.

Weight — Net: 0.5 kg (1.0 lb). Shipping: 0.9 kg (2.0 lb).

Order S-4 Sampling Head **$2,825**

S-5

1 MΩ, 15 pF Input Impedance

Passive Probe

Internal Trigger Pickoff

The S-5 Sampling Head is a low-noise, 1 ns risetime sampling unit with a 1 MΩ, 15 pF input impedance. When used with the included P6010 Passive Probe, the input impedance increases to 10 MΩ, 10 pF while maintaining the 1 ns risetime at the probe tip. A switch on the sampling head selects either ac or dc coupling of the input.

Risetime — S-5 only, 1 ns or less; with 3.5 ft P6010, 1 ns or less.

Bandwidth — Equivalent to dc to 350 MHz at 3 dB down at input connector or probe tip.

Transient Response — S-5 only (driven with a 50 Ω source terminated in 50 Ω): aberrations +2.5%, −5% or less, total of 7.5% or less p-p within 17 ns after step; +1%, −1% or less, total of 2% or less p-p thereafter.

S-5/P6010 (3.5 ft probe, properly compensated): aberrations +5%, −5% or less total of 10% or less p-p within 25 ns after step; +1%, −1% or less total of 2% or less p-p thereafter.

Displayed Noise — S-5 only, 500 μV or less (includes 90% of dots). S5/P6010, 5 mV or less (includes 90% of dots).

Signal Range — S-5 only: dc coupled, 1 V p-p from +1 V to −1 V; ac coupled, 1 V p-p. S5/P6010: dc coupled (dc + peak ac), 10 V p-p; ac coupling, dc voltage, 100 V.

Input Characteristics — S-5 only, 1 MΩ within 1% paralleled by 15 pF. S-5/P6010, 10 MΩ paralleled by ≈10 pF.

Attenuator Accuracy — Probe attenuation is 10X within 3%.

Included Accessories — 50 Ω termination (011-0049-01); P6010 Probe package (010-0188-00); instruction manual.

Weight — Net: 0.3 kg (0.6 lb). Shipping: 0.9 kg (2.0 lb).

Order S-5 Sampling Head **$1,320**

S-6

30 ps Risetime

Displayed Noise <5 mV (Unsmoothed)

Loop-Through Input

The S-6 Sampling Head is a 50 Ω feed-through unit for high-speed applications.

Risetime — 30 ps or less. 35 ps or less as observed with S-52 Pulse Generator.

Bandwidth — Equivalent to dc to 11.5 GHz at 3 dB down.

Transient Response — Pulse aberrations following the steps are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Displayed Noise — 5 mV or less, measured tangentially.

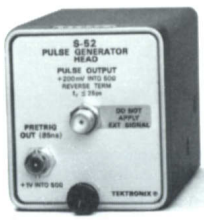
Signal Range — +1 V to −1 V (dc + peak ac). 1 V p-p. Dc offset allows any portion of input signal to be displayed.

Input Characteristics — Nominally 50 Ω, loop-through system, unterminated. SMA (3 mm) connectors. Maximum safe overload is ±5 V.

Included Accessories — 50 Ω termination (015-1022-00); 1 ns 50 Ω cable (015-1019-00); SMA (3 mm) female-to-female adaptor (015-1012-00); combination wrench (003-0247-00); SMA male-to-GR874 adaptor (015-1007-00); instruction manual.

Weight — Net: 0.5 kg (1.0 lb). Shipping: 0.9 kg (2.0 lb).

Order S-6 Sampling Head **$2,435**



TIMING HEAD CHARACTERISTICS

	Bandwidth	Risetime	Application
S-51	1 to 18 GHz trigger countdown	—	High Speed Sinewave Sampling
S-52	—	≤25 ps	High Resolution TDR
S-53	Dc to 1 GHz trigger recognizer	—	General Purpose Sampling
S-54	—	≤1 ns	Medium Resolution TDR

S-51

18 GHz Countdown

10 ps or Less Trigger Jitter

The S-51 Trigger Countdown Head is a free-running tunnel-diode oscillator designed to provide stable sampling displays of sinewaves from 1 GHz to 18 GHz. The S-51 has a front-panel sync control that synchronizes the oscillator frequency to a subharmonic of the input signal. The output from the S-51 is available at a front-panel trigger output connector and through a rear-panel connector for internal triggering. The output signal is a direct countdown of the input and permits triggering by a standard sampling time-base unit.

Input Signal — Frequency range is 1 GHz to 18 GHz. Stable synchronization on signals at least 100 mV p-p, as measured separately into 50 Ω, 5 V, p-p maximum.

Input Characteristics — 50 Ω SMA (3 mm) connector. Open termination paralleled by 1 pF.

Trigger Output — Front-panel trigger output is at least 200 mV into 50 Ω, BSM type connector. Internal trigger output is at least 100 mV into 50 Ω, internally connected to sampling unit. Jitter is 10 ps or less with signals from 5 GHz to 18 GHz; 15 ps or less with signals from 1 GHz to 5 GHz. Kickout at signal input connector is 400 mV or less; kickout occurs between successive samples.

Weight — Net: 0.5 kg (1.0 lb). Shipping: 2.3 kg (5.0 lb).

Included Accessory — Instruction manual.

Order S-51 Trigger Countdown Head **$1,380**

S-52

25 ps Risetime

200 mV into 50 Ω

50 Ω Source

Pretrigger Output

The S-52 Pulse Generator Head is a tunnel-diode step generator designed for use with the 7S12 as a high resolution Time Domain Reflectometer.

For TDR applications, the S-52 features automatic bias circuit control to eliminate effects of tunnel-diode and load changes. A 50 Ω reverse termination minimizes reflections. The pulse width is sufficient for distances up to 250 ft in any cable. A pretrigger output allows the S-52 to be operated in sequential sampling systems without a delay line.

Pulse Output — Risetime is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pulse duration when used with the 7S12 in the TDR mode is typically 750 ps. Pulse duration when powered by the 7S11 is >800 ps. Pulse period 16 μs within 2 μs. Pulse aberrations following the step are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step, +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Pretrigger Output — Risetime is 1 ns or less. Amplitude into 50 Ω is at least 1 V, positive going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 85 ns (within 5 ns) before the pulse output. Pretrigger to pulse output jitter is 10 ps or less. Pretrigger output is also available at rear connector for internal triggering of the sampling sweep unit.

Output Connectors — Pulse output uses an SMA (3 mm) connector. Pretrigger output uses a BSM connector.

Weight — Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

Included Accessories — 1 ns, 50 Ω semirigid coax delay line (015-1023-00); instruction manual.

Order S-52 Pulse Generator Head **$1,750**

S-53

Dc-to-1 GHz Operation

10 mV Sensitivity

The S-53 Trigger Recognizer Head is intended for use with the 7S12 to permit operation as a general-purpose sampling system. The S-53 supplies triggering for the 7S12.

Input Characteristics — Frequency range is dc to 1 GHz. Sensitivity range is 10 mV to 2 V p-p into 50 Ω. Kickout at input, ±5 mV or less.

Output Characteristics — Risetime is 1 ns or less. Amplitude is at least 1.5 V positive-going into 50 Ω. Pulse duration is 3 ns within 2 ns at the 50% amplitude level. Pulse period is 27 μs minimum. Trigger-to-signal delay is 15 ns or less; jitter is 15 ps or less.

Connectors — Trigger input connector is BNC type. Front-panel trigger output connector is BSM type. Trigger output is also available at rear connector for internal triggering.

Weight — Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

Included Accessories — 42 inch, 50 Ω cable (012-0057-01); 10X 50 Ω attenuator (011-0059-02); instruction manual.

Order S-53 Trigger Recognizer Head **$1,260**

S-54

1 ns Risetime

Low Aberrations

400 mV into 50 Ω

50 Ω Source

Variable Pretrigger Lead Time

The S-54 Pulse Generator Head is a step generator designed for use with the 7S12 as a long line Time Domain Reflectometer unit.

Intended for TDR applications, the S-54 is 50 Ω reverse terminated to minimize reflections and has a 0 V base line to eliminate base line shift with load changes. A continuously variable front-panel control enables adjustment of pretrigger lead time. The pretrigger output allows the S-54 to be operated in sequential sampling systems without a delay line.

Pulse Output — Risetime is 1 ns or less. Amplitude into 50 Ω is +400 mV or greater. Pulse duration is 25 μs within 2 μs. Pulse aberrations following the step are +1.5%, −1.5%, total of 1.5% p-p, as displayed with S-1 Sampling Head. Base line level is 0 V within 20 mV, terminated in 50 Ω.

Pretrigger Output — Risetime is 5 ns or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pretrigger pulse duration is 20 ns or less at the 50% amplitude point. Pretrigger lead time is front panel adjustable from 120 ns or less to 1 μs or greater. Pretrigger-to-pulse-output jitter is 100 ps or less at 120 ns lead time to 1 ns or less at 1 μs lead time.

Output Connectors — Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

Included Accessories — BNC T connector (103-0030-00); 8 inch 50 Ω cable (012-0118-00); instruction manual.

Weight — Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

Order S-54 Pulse Generator Head **$1,135**

OPTIONAL ACCESSORIES

P6040/CT-1 Current Probe
Order 015-0041-00 ..... **$143**

P6056 10X Passive Probe
Order 010-6056-03 ..... **$165**

P6057 100X Probe
Order 010-6057-03 ..... **$170**

Coupling Capacitor, GR874-K
Order 017-0028-00 ..... **$90**

Power Divider GR874-TPD
Order 017-0082-00 ..... **$350**

GR to BNC Adaptor
Order 017-0063-00 ..... **$43**

Probe Tip-to-BNC Adaptor
Order 013-0084-01 ..... **$8.00**

Probe Tip-to-GR Adaptor
Order 017-0076-00 ..... **$42**

Probe Tip-to-GR Terminated Adaptor
Order 017-0088-00 ..... **$50**

OPTIONAL SAMPLING HEAD ACCESSORIES

With SMA (3 mm) Connectors

2X 50 Ω Attenuator Order 015-1001-00 ..... **$120**
5X 50 Ω Attenuator Order 015-1002-00 ..... **$120**
10X 50 Ω Attenuator Order 015-1003-00 ..... **$120**
50 Ω Termination Order 015-1004-00 ..... **$60**
2 ns 50 Ω Signal Cable Order 015-1005-00 ..... **$80**
5 ns 50 Ω Signal Cable Order 015-1006-00 ..... **$130**
Female-to-GR874 Adaptor Order 015-1007-00 ..... **$100**
Male-to-GR874 Adaptor Order 015-1008-00 ..... **$100**
Male-to-N Female Adaptor Order 015-1009-00 ..... **$50**
Male-to-7 mm Adaptor Order 015-1010-00 ..... **$175**
Male-to-Male Adaptor Order 015-1011-00 ..... **$20**
Female-to-Female Adaptor Order 015-1012-00 ..... **$16**
Coupling Capacitor Order 015-1013-00 ..... **$180**
50 Ω Power Divider T Order 015-1014-00 ..... **$200**
500 ps 50 Ω Semrigid Cable Order 015-1015-00 ..... **$40**
SMA T Adaptor Order 015-1016-00 ..... **$30**
SMA Male-to-BNC Female Adaptor
Order 015-1018-00 ..... **$8.00**
1 ns 50 Ω Cable Order 015-1019-00 ..... **$105**
SMA Male Short-Circuit Termination
Order 015-1020-00 ..... **$17.50**
SMA Female Short-Circuit Termination
Order 015-1021-00 ..... **$24**
SMA Male 50 Ω Termination Order 015-1022-00 ..... **$32**

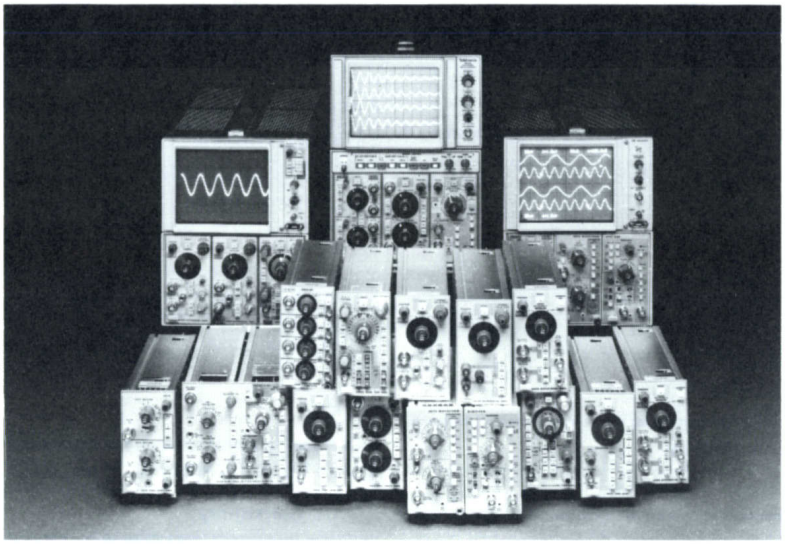
With BNC Connectors

50 Ω Feed-through Termination
Order 011-0049-01 ..... **$25**
50 Ω Feed-through (5 W) Order 011-0099-00 ..... **$40**
50 Ω 2X Attenuator Order 011-0069-02 ..... **$35**
50 Ω 2.5X Attenuator Order 011-0076-02 ..... **$35**
50 Ω 5X Attenuator Order 011-0060-02 ..... **$35**
50 Ω 10X Atteuator Order 011-0059-02 ..... **$35**
50 Ω 18 in, Coaxial Cable Order 012-0076-00 ..... **$17**
50 Ω 42 in, Coaxial Cable Order 012-0057-01 ..... **$17**

5000 SERIES INSTRUMENTS

CONTENTS

Storage Mainframes 288
Nonstorage Mainframes 287
Color Oscilloscope 292
Plug-ins 289, 293-297



Digital Storage Capability

The 5223 Digitizing Oscilloscope provides digital storage at the touch of a button, intensified pretrigger viewing, equivalent time sampling, and X-Y displays. The optional IEEE Standard 488 interface is ideal for physical, mechanical and biomedical applications. For further information see page 336 in the Digitizer Section.

Performance Value

Designed for the cost-conscious user as an alternative to the monolithic scope, the 5400 Series gives you 50 MHz bandwidth in both nonstore and variable persistence storage mainframes with CRT readout.

Maximum Flexibility

The 5100 Series is ideal for low frequency applications such as medical and mechanical measurements requiring up to 2 MHz bandwidth. It gives you unparalleled choices in measurement flexibility such as dual-beam, split-screen, bistable storage displays, differential inputs and spectrum analysis.

The ***NEW*** 5116 combined with a 5D10 Waveform Digitizer provides unique three-color display in addition to the digital storage capabilities and features of the 5D10.

Expandability

With the 5000 Series plug-in oscilloscope, you are making a cost-effective investment in current technology—and ensuring yourself a share in the future.

5000 SERIES VERTICAL AMPLIFIER CHARACTERISTICS

	5A13N	5A14N	5A15N	5A18N	5A19N	5A21N	5A22N	5A26	5A38	5A48
PAGE	**295**	**294**	**294**	**294**	**295**	**295**	**296**	**296**	**289**	**289**
Performance Feature	Differential Comparator Single Trace	Four Trace	Single Trace	Dual Trace	Differential Single Trace	Differential*1 Single Trace	Differential Single Trace	Dual Differential	Dual Trace	Dual Trace
Minimum Deflection Factor	1 mV/div	1 mV/div	1 mV/div	1 mV/div	1 mV/div	50 μV/div 0.5 mA/div	10 μV	50 μV/div	10 mV/div	1 mV/div*3
Bandwidth −3 dB	2 MHz	1 MHz	2 MHz	2 MHz	2 MHz	1 MHz	1 MHz	1 MHz	35 MHz	50 MHz
CMRR	10,000:1				1,000:1	100,000:1	100,000:1	100,000:1		
Mainframe Compatibility	• **Indicates Recommended Combination**									
5110 Single Beam 5111A Bistable Storage, Single Beam 5113 Bistable Storage, Dual Beam 5116 3-Color Display	•	•	•	•	•	•	•	•		
5223 Digital Storage, Single Beam 5440 Single Beam 5441 Variable Persistence Storage, Single Beam	•*2	•*2	•*2	•*2	•*2	•*2	•*2	•*2	•	•

*1 Voltage and current probe inputs.

*2 Compatible, but does not provide CRT readout.

*3 Bandwidth is dc to 25 MHz at 1 mV/div and 2 mV/div.

5000 SERIES MAINFRAME/TIME BASE RECOMMENDATIONS

PRODUCT						MAINFRAMES						
Time Base	**Performance Feature**	**Sweep Rate**	**Mag**	**Single Sweep**	**Volts/Div Ext Mode**	**5110**	**5111A**	**5113**	**5116**	**5223**	**5440**	**5441**
						• **Indicates Recommended Combination**						
5B10N	Single Sweep Time Base/Amplifier	1 μs to 5 s	X10	Yes	50 mV & 500 mV	•	•	•	•	•*1	•*2	•*2
5B12N	Dual Sweep Time Base	A-1 μs to 5 s B-2 μs to 0.5 s	X10	Yes —	50 mV & 500 mV	•	•	•	•	•*1	•*2	•*2
5B40	Single Sweep Time Base	0.1 μs to 5 s	X10	Yes	50 mV					•*1	•	•
5B42	Delaying Time Base	A-0.1 us to 5 s B-0.1 μs to 0.5 s	X10 X10	Yes —	50 mV					•*1	•	•
5B25N	Digital Time Base for 5223	0.2 μs to 5 s	X10	Yes	50 mV					•	•*2	•*2
Special Purpose Plug-ins												
5CT1N	Semiconductor Curve Tracer					•	•	•	•	•	•	•
5S14N	Dual Trace Delayed Sweep Sampler					•	•	•		•	•	•
5D10	Waveform Digitizer					•	•	•	•*3	•	•	•

*1 Compatible, but does not provide digital storage.

*2 Compatible, but does not provide CRT readout.

*3 Required for color display.

Low Cost

2 MHz, 10 MHz or 50 MHz Bandwidth

Sampling to 1 GHz

0 to 100 kHz Spectrum Analysis

Seven Oscilloscope Models

Wide Choice of Plug-Ins

Color, Digital, Dual-Beam & Storage Displays

CRT Readout (5400 Series Only)

Large 6.5 Inch CRT (8 x 10 Div)

10 μV/Div High Gain Differential Amplifier

One to Eight Trace Capability

Delayed-Sweep Time Bases

Y-T or X-Y Operation

Bench-to-Rack Convertibility

The 5000 Series oscilloscopes are designed to provide optimum versatility and performance at the lowest possible price.

5100 SERIES OSCILLOSCOPES

Four 5100 Series oscilloscopes are available. They include single-beam, dual-beam, and storage displays. The storage display units feature bistable, split-screen storage with large 6.5 inch CRTs. The dual beam units have two writing guns and two pairs of vertical deflection plates. One pair of horizontal deflection plates drives both beams.

The 5100 Series also features 2 MHz mainframes with large 6.5 inch single-beam CRTs that accommodate two vertical deflection plug-ins and one horizontal deflection plug-in. They can be easily converted from bench to rackmount configuration.

There is a wide choice of plug-ins available for use with the 5100 Series. Among these are the 5S14N, a general purpose 1 GHz dual-trace sampling plug-in and the 5D10 Waveform Digitizer.

The 5116 Oscilloscope is a new low-cost, single-beam scope which offers the modularity and flexibility of Tek's popular 5000 Series oscilloscopes. When used with a Tektronix 5D10 Waveform Digitizer, it provides a unique three-color display in addition to the digital storage capabilities and features of the 5D10.

5223 DIGITIZING OSCILLOSCOPE

You can get the benefits of digital storage, along with the time-tested advantages of a conventional analog scope, in the 10 MHz 5223 Digitizing Oscilloscope. Combined in one powerful, convenient oscilloscope are pushbutton ease, high quality waveform display, pretrigger signal manipulation, and optional GPIB interface, plus real-time analog display capability.

Use the 5223 in the digital storage mode to capture repetitive events at speeds of up to 10 MHz or single-shot events at speeds of up to 100 kHz. The maximum sample rate is 1 MHz; storage capacity is 1024 bits per vertical compartment.

The digitized display will never fade or bloom, so you get more accurate measurements, more conveniently. High 10-bit vertical resolution gives you an accurate representation of your signals.

For further information see page 348 in the Digitizer Section.

5400 SERIES OSCILLOSCOPES

Two 5400 Series display units are presently available: a single-beam, nonstorage display and a variable persistence storage display. Both feature CRT readout of plug-in scale factors, three plug-in compartments and benchmount-to-rackmount convertibility.

The 5400 Series offers 50 MHz bandwidth and is capable of satisfying a wide range of measurement needs. It features readout of plug-in scale factors on the CRT (except with plug-ins having a suffix N: 5A22N, 5B10N, etc.). This feature, previously available only on more sophisticated oscilloscopes, allows you to make measurements more quickly and conveniently. The CRT readout can also be externally accessed (Option 03).

PLUG-IN VERSATILITY

A wide choice of plug-ins are available in the 5000 Series family. All these plug-ins are compatible with the 5400 Series, and all but six are compatible with 5100 Series mainframes.

The amplifier plug-ins include single, dual, and four trace units, various differential amplifiers (including one with a current probe input), and a differential comparator amplifier. The time-base plug-ins include single, dual, delayed sweep units, and a digital time base.

Three special-purpose plug-ins are also available. The 5CT1N is a semiconductor curve tracer plug-in. It allows characteristic curves of transistors, FETs, diodes and other semiconductor devices to be displayed on the CRT. The 5S14N, a general-purpose dual-trace, delayed sweep sampler, extends the bandwidth of the 5100, the 5400 Series, and the 5223 to 1 GHz at 2 mV sensitivity.

The 5D10 is a dual channel waveform digitizer with cursors, CRT scale factor readout, roll mode and plotter output.

Back-lighted knob skirts on the plug-ins provide scale-factor readout. The correct scale factor is automatically indicated when using the X10 magnifier and the recommended 1X and 10X probes. In addition, the 5400 Series automatically presents correct scale factors on the CRT when used with non-N suffix plug-ins. This feature helps reduce human errors and enables photographic recording of measurement conditions.

CARTS

SCOPE-MOBILE® Carts — For cabinet models, order TEK Lab Cart, Model 3.

CAMERAS

All 5100 Series — C-5C, suitable for repetitive or stored traces.

5100 Storage Instruments, 5440 (with P back), 5441 (with G back) — C-59, general purpose.

For full details see camera section.

OPTIONAL ACCESSORIES

Blank Plug-in Kit — Order 040-0818-03 ..... **$105**
Blank Panel — Order 016-0195-03 ..... **$25**
Viewing Hoods — Order 016-0154-00 ..... **$28**
or Order 016-0452-00 folding **$18**
Protective Cover — Order 016-0544-00 ..... **$25**
For full details see accessories section.

5000 SERIES INSTRUMENTS—PHYSICAL CHARACTERISTICS

	5223				5100 and 5400 Series				Plug-ins			
	Cabinet		Rackmount		Cabinet		Rackmount		Single Width		Double Width	
Dimensions	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**
Width	213	8.4	483	19.0	213	8.4	483	19.0	66	2.6	132	5.2
Height	328	12.9	178	7.0	302	11.9	133	5.25	127	5.0	127	5.0
Depth	572	22.5	569	22.4	518	20.4	483	19.0	305	12.0	305	12.0
Weight ≈	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net	16.9	37.3	19.1	42.0	10.4	23.0	10.9	24.0	1.3	2.8	2.6	5.8
Shipping	20.5	45.0	23.6	52.0	10.5	32.0	19.5	43.0	4.5	10.0	4.9	10.8

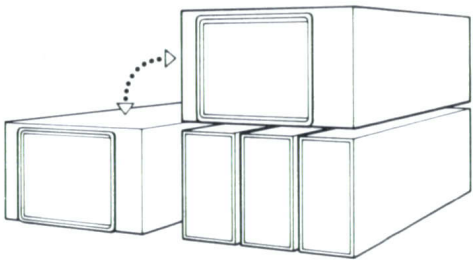
RECOMMENDED PROBES FOR 5000 SERIES AMPLIFIER PLUG-INS

The following probes are recommended for general use with the listed amplifier plug-ins. These probes automatically program the knob-skit readout and the CRT readout (available only in the 5400 Series) to indicate correct deflection factor. Probe packages include various tips, ground leads and accessories.

Probes are also available in different lengths, attenuation ratios, input loading and bandwidths. Special purpose probes, such as high voltage, FET and current probes are available for use with 5000 Series amplifier plug-ins. See probe section for complete information.

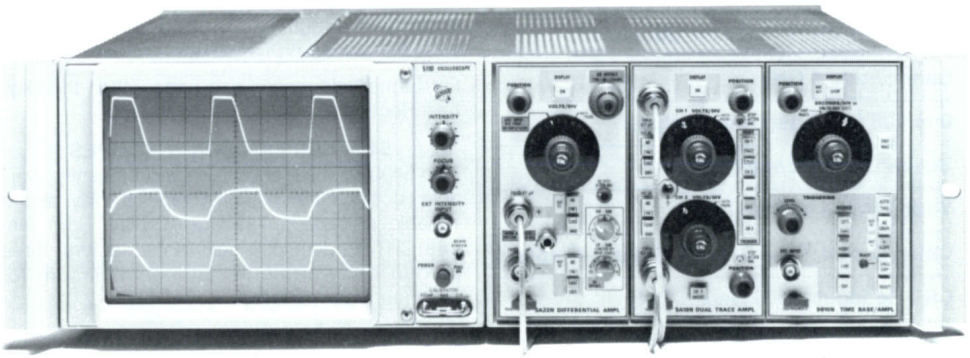
Amplifier Plug-ins	Voltage Probe	Attenuation	Standard Length	Features	Package Number
5A14N 5A15N 5A18N	P6108	10X	2 m	Full bw, modular (not compatible with CRT readout).	010-6108-03
	P6062B	1X/10X	6 ft	Full bw, switchable attenuation, ground reference button.	010-6062-13
5A13N 5A21N*1 5A22N 5A26	P6062B	1X/10X	6 ft	Full bw, switchable attenuation, ground reference button.	010-6062-13
	P6101	1X	2 m	Full bw, miniature. Modular construction simplifies repair.	010-6101-03
	P6055	Adjustable to 10X	3.5 ft	Adjustable attenuation. Will give up to 20,000; 1 CMRR when used in pairs. (5A21N, 5A22N and 5A26).	010-6055-01
5A38 5A48 5D10	P6122	10X	1.5 m	Full bw, miniature, low cost, modular.	010-6122-01
	P6105	10X	2 m	Full bw, miniature. Modular construction simplifies repair.	010-6105-03
	P6062B	1X/10X	6 ft	Switchable attenuation (full bandwidth in the 10X position) ground reference button.	010-6062-13
	P6101	1X	2 m	Miniature, modular (reduced bandwidth).	010-6101-03

*1 *The 5A21N also provides direct access to current probe P6021. Order 5A21N, Option 01 for 5A21N Amplifier and Current Probe package. See page 295 for complete information.*



CONVERSION KITS

Cabinet-to-Rackmount Order 040-0583-03 ..... **$95**
Rackmount-to-Cabinet Order 040-0584-04 ..... **$150**
Rackmount-to-Cabinet (R5223 Only)
Order 040-0975-01 ..... **$230**
Cabinet-to-Rackmount (5223 Only)
Order 040-0976-04 ..... **$315**



All 5000 Series rackmount oscilloscopes and cabinet-to-rackmount kits include complete slide out tracks and mounting hardware to interface with standard 19 inch racks.

MECHANICAL MEASUREMENT TRANSDUCERS

Transducer Package	Description	Performance	Recommended Accessories
PRESSURE 015-0161-00*1	Range: 3000 psig Type: Bonded Strain Gage 4 arm 350 Ω bridge Built-in CAL resistor	Accuracy: 1% Excitation: ≈10 V dc Scale Factor: 3 mV/V fs fn ≈65 kHz	012-0209-00 20 ft multi-conductor cable
PRESSURE 015-0162-00*1	Range: 300 psig Type: Bonded Strain Gage 4 arm 350 Ω Bridge Built-in CAL resistor	Accuracy: 1% Excitation: ≈10 V dc Scale Factor: 3 mV/V fs fn ≈24 kHz	012-0209-00 20 ft multi-conductor cable
PRESSURE (EAS) 015-0117-00	Range: 3000 psig (dynamic only) Type: Piezoelectric	Accuracy: <5% Sensitivity: 200 pc/psi Max Overpressure: 300% Temp: −40°C to +150°C max	015-0118-00 cooling adaptor
ACCEL-ERATION 015-0165-00	Range: 0.001 to 1000 g's Type: Piezoelectric compression High capacitance (≈10,000 pF) NBS traceability	Accuracy: 5% Linearity: 2% Sensitivity: ≈12 mV/g fn ≈30 kHz	012-0211-00 microdot to BNC 20 ft cable
VIBRATION (EAS) 015-0116-00	Range: 0.01 to 100 g's (100 to 10,000 RPM) Type: Piezoelectric magnetically mounted	Sensitivity: 6 mV/g (oc) Cr ≈3500 pF Temp: −40°C to +150°C fn ≈11 kHz	012-0137-00 BNC-BNC cable 50 ft
VERTICAL VIBRATION 015-0166-00 HORIZONTAL VIBRATION 015-0167-00	Type: Seismic (geophone) Self-generating Signals: Velocity Displacement (integrated velocity) Range: 0.050 in p-p	Accuracy: <5% Scale Factor: Velocity ≈600 mV/in/s Displacement ≈10 mV/0.002 in Freq Range: 10 Hz to 2 kHz fn ≈8 Hz Temp: −40°C to +71°C	012-0136-00 BNC-BNC cable 20 ft long
FORCE (Displacement) 015-0164-00*1	Range: 50 grams 50 lbs (with load cell) 0.120 mm Type: Unbonded 350 Ω Strain Gage 4 arm bridge	Accuracy: 0.5% Excitation: ≈5 V dc Full Scale Output: 60 to 80 mV Temp: −50°C to +85°C and tools	Included with unit is 50 lb (22 to 5 kg) load cell connect-ed, power cable attachment bracket
DISPLACE-MENT 015-0168-00	Range: ±4.0 mm (Calibrated & usable to ±0.2 in) Type: Dc to dc LVDT	Accuracy: 2% linearity <1% Excitation: 3 to 11 V dc Scale Factor: 1 V/mm at 8.5 V dc 20 mV/0.001 inch at 7.5 V dc Temp: −54°C to +60°C	012-0209-00 20 ft cable
STRAIN 015-0171-00	Range: 30,000 μ Strain Type: Foil Strain Gage 0.125 in long. Attached leads Package of five	Resistance: 120 Ω Gage Factor (nominal) 2.1 Accuracy: 1% Excitation: (bridge), 5 V max	Strain Gage Adaptor 015-0169-00 Cement Kit 015-0172-00
STRAIN GAGE ADAPTOR 015-0169-00*1	Provides means for connecting 1, 2, or 4 arms of a Wheatstone Bridge to the Type PS 501-1 Mod 730E Transducer Power Supply. Has variable shunt resistor for gage factor calibration. The adaptor has 4 binding post terminals and a 6-foot cable with 6-pin connector.	Accuracy: Governed by initial calibration and strain gages used. Strain Gage Resistance Range: 30 Ω to 5000 Ω for 4 arm bridges. 120 Ω for 1, 2 or 4 arm bridges. Bridge Volts: Typically 5 V for 120 Ω gages. Gage Factor Correction Range: 1.7 to 2.3	Strain Gage Package, 015-0171-00 Cement Kit, 015-0172-00
CEMENT KIT 015-0172-00	Provides means for mounting and connecting foil strain gages. Includes Room Temperature Curing Epoxy cement, RTV Clear Silicon Rubber coating. Neoprene pads and metal plates cementable Wiring terminals, and clear Mylar film.		Strain Gage Package 015-0171-00

**1 Requires PS 501-1 custom modified Transducer Power Supply mounted in a TM 500 Series mainframe. Consult a Tektronix Sales Engineer for price and installation information on power supply and adaptor.*

Cable — 20 ft low-noise cable with BNC connectors on both ends. Order 012-0136-00 ..... **$70**

Cable — 20 ft low-noise 6-conductor cable with 6-pin connector on each end. Order 012-0209-00 ..... **$315**

Cable — 20 ft 6-conductor cable with 6-pin male connector on 1 end. Order 012-0210-00 ..... **$115**

Cable — 20 ft low-noise coaxial cable with minature coaxial connector on 1 end and BNC connector on the other. Order 012-0211-00 ..... **$40**

Cable — 50 ft low-noise cable with BNC connectors on both ends. Order 012-0137-00 ..... **$90**

Connector — Mates Type PS 501-1 Transducer Power Supply Input 6-pin connector. Order 131-0618-00 ..... **$44**

Cooling Adaptor — For use with 015-0117-00 Pressure Transducer to keep body temperature at or below +150°C. Also reduces effects of preignition explosions. Order 015-0118-00 ..... **$600**

APPLICATION NOTES

Following is a list of currently available Application Notes for 5000 Series oscilloscopes.

Title Featuring	Request Number
STRUCTURAL TESTING The Digitizing Approach 5223/5B25N/5A18N Single-shot techniques. Multitrace using transducers.	AX-4461
BIOPHYSICAL DATA RETRIEVAL The Digitizing Approach 5223/5B25N/5A18N Roll mode, chart recorder output.	AX-4462
RECORDING ELECTRO-PHYSIOLOGICAL NERVE ACTIVITY Using a plug-in oscilloscope 5113/5A26/5A22N Low level measurements and storage.	AX-3746
INTERPRETING MECHANICAL MEASUREMENTS WITH THE PLUG-IN OSCILLOSCOPE 5111/5A22N/5A18N Transducer measurements and storage.	AX-3533-1
SIMULTANEOUS DISPLAY OF TWO INDEPENDENT X-Y SIGNAL PAIRS 5111/5A15/5A15N/5A18N. Dual X-Y techniques, engine analysis.	AX-4114
SIMULTANEOUS X-Y, Y-T DISPLAYS 5111/5A15N/5A15N/5B12N. X-Y, Y-T techniques. Biomedical application.	AX-4113
CUSTOM PLUG-IN IDEAS FOR 5000 SERIES SCOPES Recommended starter note for customers considering custom plug-in project.	AX-3758
A HIGH RESOLUTION 60 Hz NOTCH FILTER Construction project using a commercial module in our plug-in kit. Preconditions signals by removing 60 Hz hum.	AX-4031
A TRUE RMS CONVERTER Construction project using thermal true RMS converter module in our blank plug-in kit. Measures true RMS up to 200 V RMS.	AX-4112

TRANSDUCER PACKAGE PRICE LIST

015-0161-00	$825	015-0167-00	$525
015-0162-00	$695	015-0164-00	$915
015-0117-00	$1,625	015-0168-00	$645
015-0165-00	$470	015-0169-00	$445
015-0116-00	$1,000	015-0171-00	$42
015-0166-00	$265	015-0172-00	$115

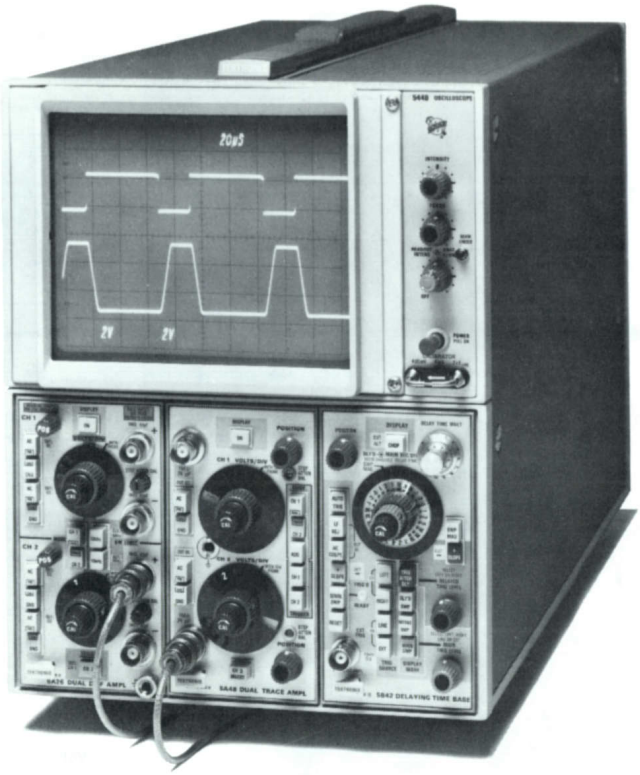
50 MHz GENERAL PURPOSE OSCILLOSCOPE

5440/R5440

- Low Cost
- Dc to 50 MHz
- Sampling to 1 GHz
- CRT Readout
- 3 Plug-in Flexibility
- Wide Choice of Plug-ins
- Bench to Rack Convertibility

APPLICATIONS

- ✱ Electrical Engineering
- ✱ Component Testing
- ✱ Ultrasonics



The 5440 combines versatility and low cost in a 50 MHz general-purpose, plug-in oscilloscope. It features CRT readout of plug-in scale factors, a three plug-in mainframe, a wide choice of plug-ins*1 and bench to rack convertibility.

CRT readout displays plug-in scale factors on the CRT, so measurement time and operator errors are reduced by taking into account magnifiers and probe attenuators. It can also be accessed externally. This unique ability can be used to read out dates, picture numbers, digital clock times, etc (with Option 03 User Addressable CRT Readout).

All the plug-ins in the 5000 Series are compatible with the 5440.*2

The wide variety of plug-ins available lets you configure your oscilloscope to meet your needs today as well as tomorrow: from a single-trace, single time-base configuration for production monitoring, to 4-trace, delayed sweep for logic work, to 4-trace differential amplifiers for transducer measurements, to dual-trace, delayed sweep for general purpose measurements.

If you're looking for a general-purpose oscilloscope, the 5440 gives you the most versatility and performance at the lowest price.

*1 *Plug-ins with a suffix N (5B12N, etc.) do not provide CRT readout.*

*2 *The 5B10N and 5B12N Time Bases do not permit viewing the leading edge of a triggered waveform when used in the 5400 Series.*

CHARACTERISTICS

VERTICAL SYSTEM

Channels — Left and center plug-in compartments are compatible with all 5000 Series plug-ins. CRT readout is not available with plug-ins having a suffix N (5A18N, etc.).

Deflection Factor — Determined by plug-in unit.

Bandwidth — 50 MHz, determined by plug-in unit.

Chopped Mode — The 5440 will chop between channels at ≈25 to 100 kHz, depending on plug-ins and operating modes.

Alternate Mode — Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5440 switches to the second amplifier.

HORIZONTAL SYSTEM

Channel — Right-hand plug-in compartment compatible with all 5000 Series plug-ins. CRT readout is not available for plug-ins with a Suffix N (5B10N, etc.).

Internal Trigger Mode — Left vertical, center vertical.

Fastest Calibrated Sweep Rate — 10 ns/div, determined by plug-in.

X-Y Mode — Phase shift within 2° from dc to 20 kHz.

CRT AND DISPLAY FEATURES

CRT — Internal parallax-free 8 x 10 div (1.22 cm/div) graticule with edge-lit illumination.

Phosphor — GH (P31) standard, GM (P7) or BE (P11) optional.

Accelerating Potential — 15 kV.

External Intensity Input — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range dc to 2 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (dc + peak ac).

OTHER CHARACTERISTICS

Calibrator — Voltage amplitude is 400 mV within 1%. Current is 4 mA within 1%. Frequency is two times the line frequency.

Minimum Photographic Writing Speed — Using Polaroid film 20,000 ASA without film fogging. Writing speed can be increased with the Tektronix Writing Speed Enhancer (see camera section for more information).

Writing Speed cm/μs				Camera	Lens
GH (P31) Phosphor		BE (P11) Phosphor			
20,000 ASA	3000 ASA	20,000 ASA	3000 ASA		
180	90	245	125	C-59P	f/2.8 0.67 mag
330	160	450	230	C-50P*1*2	f/1.9 0.7 mag

*1 *Slight cropping of the graticule corners.*

*2 *Requires optional battery pack (016-0270-02) for operation with the 5440.*

Beam Finder — Intensifies trace and brings it into graticule areas.

Ambient Temperature — Performance characteristics valid from 0°C to +50°C unless otherwise specified.

Line Voltage Range — 100, 110, 120, 200, 220, and 240 V ac ±10%; (Except that maximum input should not exceed 250 V ac) internally selected with quick change jumpers. Line frequency range, 48 Hz to 440 Hz.

Maximum Power Consumption — 100 W at 120 V ac, 60 Hz.

Included Accessory — Instruction manual.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

The 5440 may be ordered as a cabinet-model oscilloscope equipped with a tilt bail, or as a 5.25 inch rackmount oscilloscope with slide-out assembly.

5440 Oscilloscope **$2,760**

R5440 Oscilloscope (Rackmount) **$2,815**

Option 01 — Without CRT Readout. The 5440 may be ordered without CRT readout. This feature can easily be added later with a conversion kit. ..... **−$300**

Option 03 — User Addressable CRT Readout. Additional CRT readout access is available for programming two 10-digit characters such as time, operator name, or test number. The additional display is useful for photographic records and is programmed by external resistors and switches. ..... **+$75**

Option 04 — Protective Panel Cover (Cabinet Model Only). The 5440 may be ordered with a protective front-panel cover to protect the front panel and knobs during transportation and storage. ..... **+$25**

Option 76 — GM (P7) Phosphor ..... **+$50**

Option 78 — BE (P11) Phosphor ..... **+$50**

CONVERSION KITS

Cabinet-to-Rackmount — Order 040-0583-03 ..... **$95**

Rackmount-to-Cabinet — Order 040-0584-04 ..... **$150**

CRT Readout — Order 040-0691-02 ..... **$755**

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

For recommended cameras refer to camera section.

5441/R5441

Low Cost

Variable Persistence Storage

CRT Readout

Dc to 50 MHz

Three Plug-in Flexibility

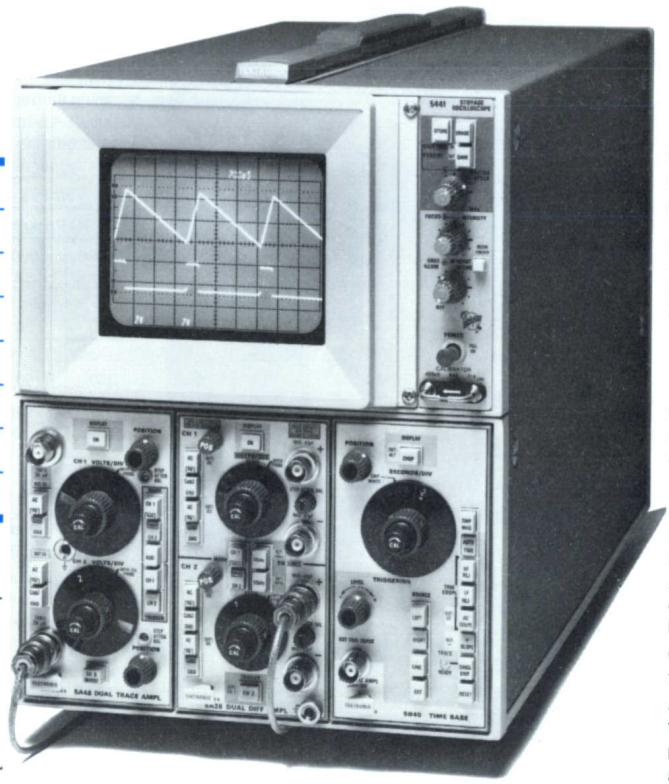
Wide Choice of Plug-ins

Bench to Rack Convertibility

5 div/μs Stored Writing Speed

APPLICATIONS

* **Ultrasonics**
* **Low Power Laser**
* **Fiber Optics**



With the 5441 Variable Persistence Storage Oscilloscope, view time at normal intensity can be varied from a fraction of a second to more than five minutes. In the save mode, signals can be viewed at lower intensity for up to an hour.

High-speed events that occur only once or at very low repetition rates are easily observed. You can make low frequency measurements more easily and accurately by eliminating flicker or transforming a slowly moving dot into a stable display. Repetitions of the same signal can be compared simultaneously to detect changes in amplitude or phase. The integrating effect of variable persistence can be used to suppress the random noise that obscures low signal-to-noise ratio waveforms.

The 5441 enhances the capabilities of the 5000 Series sampler plug-in. In sampling applications, discrete dot traces are converted into a continuous waveform by holding repeated sweeps on the CRT.

Like other 5400 Series oscilloscopes, the 5441 offers CRT readout of deflection factors for convenient, error-free measurements and optional user-programmable CRT readout of test information for ready identification and easy photographic recording. With the flexibility of a three plug-in mainframe and a wide choice of plug-ins, you can make virtually any measurement from dc to 50 MHz.

CHARACTERISTICS

VERTICAL SYSTEM

Channels — Left and center plug-in compartments compatible with all 5000 Series plug-ins. CRT readout not available for plug-ins with suffix N (5A18N, etc.).

Deflection Factor — Determined by plug-in.

Bandwidth — 50 MHz, determined by plug-in.

Chopped Mode — The 5441 will chop between channels at ≈25 kHz to 100 kHz, depending on plug-ins and operating modes.

Alternate Mode — Each plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5441 switches to the second amplifier.

HORIZONTAL SYSTEM

Channel — Right-hand plug-in compartment compatible with all 5000 Series plug-ins. CRT readout not available for plug-ins with suffix N (5B10N, etc.).

Internal Trigger Mode — Left vertical, right vertical.

Fastest Calibrated Sweep Rate — 10 ns/div, determined by plug-in.

X-Y Mode — Phase shift within 2° from dc to 20 kHz.

CRT AND DISPLAY FEATURES

CRT — Internal, parallax-free, 8 x 10 div (0.9 cm/div) graticule with edge-lit illumination.

Persistence — Continuously variable, may be turned off when not needed, thus producing high-contrast stored displays without the characteristic fading of variable persistence.

Phosphor — GH (P31) is standard.

Accelerating Potential — 8.5 kV.

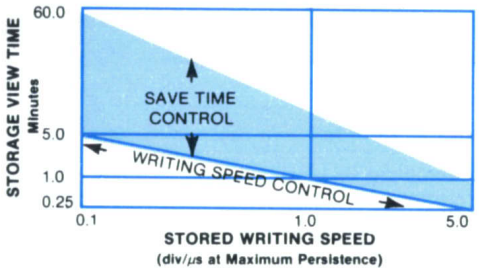
Maximum Stored Writing Speed — Writing speed >5 div/μs for a view time of 15 s.

Storage View Time — The view time is the amount of time the stored signal can be viewed before it fades away.

At the maximum writing speed the view time is 15 seconds with the writing speed control fully cw. Adjusting the stored intensity ccw will reduce the stored writing speed, but view time can be increased up to 5 minutes (see the chart next column).

Save Mode — Extends view time of stored displays up to 1 hr; prevents erasure of stored display and storage of unwanted displays.

Erase Time — 0.5 s ±10%.



External Intensity Input — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Dc to 2 MHz usable frequency range. Input R and C ≈10 kΩ paralleled by ≈40 pF. Maximum input 50 V (dc + peak ac).

OTHER CHARACTERISTICS

Beam Finder — Intensifies trace and brings it into graticule area.

Auto Focus — Reduces the need for manual focusing with changes in intensity after the front-panel Focus control has been set.

Calibrator — Voltage amplitude 400 mV ±1%. Current amplitude 4 mA ±1%. Frequency is 2 times line frequency.

Ambient Temperature — Performance characteristics valid from 0°C to +50°C unless otherwise specified.

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; (except that maximum input should not exceed 250 V ac) internally selected with quick change jumpers. Line frequency range, 48 Hz to 440 Hz.

Maximum Power Consumption — 100 W at 120 V ac, 60 Hz.

Included Accessory — Instruction manual.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

5441 Oscilloscope **$4,675**

R5441 Oscilloscope (Rackmount) **$4,725**

Option 01 — Without CRT Readout. The 5441 may be ordered without CRT readout. This feature can easily be added later with a conversion kit. ..... **−$300**

Option 03 — User Addressable CRT Readout. CRT readout access allows the operator to program up to two 10-digit words. ..... **+$75**

Option 04 — Protective Panel Cover (Cabinet Model Only). The 5441 may be ordered with a protective front-panel cover to protect the front panel and knobs during transportation and storage. ..... **+$25**

CONVERSION KITS

Cabinet-to-Rackmount — Order 040-0583-03 ..... **$95**

Rackmount-to-Cabinet — Order 040-0584-04 ..... **$150**

CRT Readout — Order 040-0691-02 ..... **$755**

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

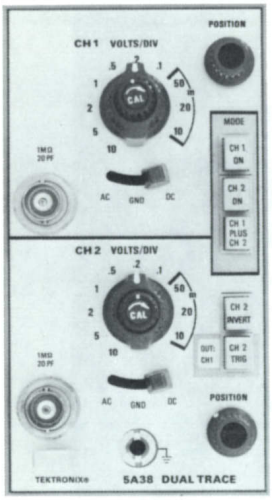
Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

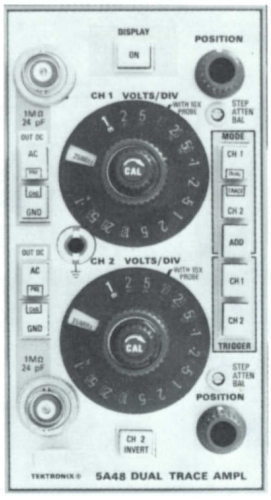
For recommended cameras refer to camera section.

5A38



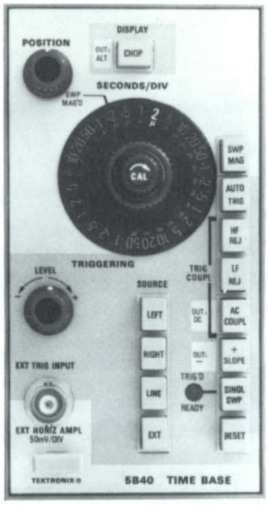
Dc to 35 MHz

5A48



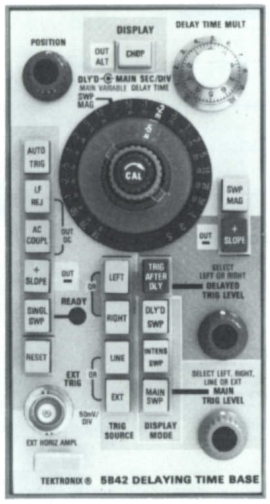
Dc to 50 MHz

5B40



Time Base

5B42



Delaying Time Base

5B40/5B42 Time Bases

Single Sweep

10 ns/div to 5 s/div Calibrated Time Base

Triggering to 50 MHz

The 5B40/5B42 Time Bases are designed for use in 5400 Series mainframes. They feature sweep rates from 10 ns/div to 5 s/div and CRT readout of the sweep rate selected. The 5B42 also features delayed sweep rates up to 10 ns/div.

CHARACTERISTICS

The following characteristics are the same for the 5B40 and 5B42 unless otherwise noted.

Sweep Rate — 0.1 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

Sweep Accuracy — Measured in 5400 Series oscilloscope over center 8 graticule divs. Valid for 100 div of magnified sweep after the first 30 ns.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
5 s/div and 2 s/div, 0.2 μs/div and 0.1 μs/div	4%	5%	5%	6.5%

Triggering Sensitivity

Coupling	Frequency Range	Minimum Signal Required	
		Internal	External
Dc 5400 ampl	Dc to 10 MHz	0.4 div*1	60 mV*1
		0.4 div*2	100 mV*2
5400 ampl	10 MHz to 60 MHz	1.0 div*1	150 mV*1
		1.0 div*2	400 mV*2
5100 ampl	Dc to 2 MHz	0.4 div*2	100 mV*2
Ac	Trigger requirements increase below 50 Hz		
LF Rej	Trigger requirements increase below 7.5 kHz		
HF Rej	Trigger requirements increase above 50 kHz*1		

*1 *5B40 only.* *2 *5B42 only.*

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

Ext Trigger Input — Max Input Voltage: 350 V dc + peak ac, 350 V p-p ac at ≤1 kHz. Input R and C: 1 MΩ paralleled by ≈24 pF. Trigger Level Range: ≥ ±1.5 V (5B40) and ±2.5 V (5B42).

Ext Horizontal Input — Deflection Factor: 50 mV/div ±3%. Input R and C is 1 MΩ paralleled by ≈24 pF. Dc Coupled Bandwidth: Dc to ≤2 MHz. Ac Coupled Lower Response: ≤50 Hz. Max Input Voltage: 350 V (dc + peak ac) or 350 V p-p ac at ≤1 kHz.

DELAYING SWEEP (5B42 only)

Delay Time Multiplier Range — 0.2 to 10 times the Time/Div setting.

Differential Time Measurement Accuracy — Within 1% plus 0.2% of full scale from 1 μs to 0.5 s delay time. Within 2% plus 0.2% of full scale of 1 s to 5 s delay time.

Jitter — <0.05% of the time represented by 1 division of delaying sweep selected.

DELAYED SWEEP (5B42 only)

Sweep Rate — 0.1 μs/div to 0.5 s/div in 21 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier.

Sweep Accuracy — Measured over the center 8 division. Same as undelayed sweep.

Triggering — The same as the internal triggering specifications in the table above.

Included Accessory — Instruction manual.

ORDERING INFORMATION

5B40 Time Base **$695**

5B42 Delaying Time Base **$1,280**

5A38 Dual-Trace Amplifier

Low Cost

Dc to 35 MHz Bandwidth

10 mV/div to 10 V/div Calibrated Deflection Factors

The 5A38 is a dual-trace, 35 MHz plug-in amplifier for use only in the 5223 and the 5400 Series mainframes. It features 10 mV/div sensitivity and CRT readout of deflection factor.*1

CHARACTERISTICS

Bandwidth — Dc Coupled: To ≥35 MHz. Lower End Response, Ac Coupled: ≤10 Hz.

Display Modes — Channel 1 only, Channel 2 only (normal or inverted), Dual-Trace, and Added. Alternated or chopped operation determined by time base plug-in. Internal trigger selectable from Channel 1 or Channel 2.

Risetime — ≤10 ns.

Deflection Factors — Calibrated: 10 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy: ≤3% from 15°C to 35°C, 4% from 0°C to +50°C. Uncalibrated: Continuously variable control provides ≥2.5X additional attenuation on each range.

Channel Isolation — ≥50:1 to 35 MHz with both traces displayed.

Input R and C — 1 MΩ paralleled by ≈20 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac). Ac Coupled: 500 V (dc + peak ac). Ac Component: 500 V p-p maximum at 1 kHz or less.

Stability — ≤0.3 mV vertical shift in any one minute after 1 hr warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

Included Accessory — Instruction manual.

Order 5A38 Dual-Trace Amplifier **$675**

*1 CRT readout not functional in 5223.

5A48 Dual-Trace Amplifier

Dc to 50 MHz Bandwidth

1 mV/div to 10 V/div Calibrated Deflection Factors

The 5A48 is a dual-trace 50 MHz plug-in amplifier for use only in the 5223 and the 5400 Series mainframes. The 5A48 features five operating modes, selectable trigger source, and CRT readout of deflection factor.*1

CHARACTERISTICS

Bandwidth — Dc Coupled: Dc to at least 50 MHz at 5 mV/div to 10 V/div, decreasing to dc to 25 MHz at 1 mV/div and 2 mV/div (3 dB down). Ac Coupled: 10 Hz or less (1.0 Hz with a 10X probe) at all deflection factors (3 dB down).

Display Modes — Channel 1 only, Channel 2 only (normal or inverted), Dual-trace, Added, Alternated, Chopped (determined by time-base plug-in horizontal compartment). Internal Trigger Source: Selectable from Channel 1 or Channel 2.

Risetime — 7 ns or less (5 mV/div to 10 V/div), 14 ns or less (1 mV/div and 2 mV/div).

Deflection Factors — Calibrated: 1 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy: ≤5% at 1 mV/div and 2 mV/div; ≤3% from 5 mV/div to 10 V/div from +15°C to +35°C; ≤4% from 5 mV/div to 10 V/div from 0°C to +50°C. Uncalibrated: Continuously variable control provides ≥2.5X additonal attenuation on each range.

Input R and C — 1 MΩ within 1% paralleled by ≈24 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac. Ac Coupled: 500 V (dc + peak ac). Ac Component: 500 V p-p maximum, 1 kHz or less.

Stability — ≤0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

Included Accessory — Instruction manual.

Order 5A48 Dual-Trace Amplifier **$995**

*1 CRT readout not functional in 5223.

For recommended probes — refer to page 285.

5100 Series Oscilloscopes

Low Cost

Dc to 2 MHz

Sampling to 1 GHz

Wide Choice of Plug-ins

Rear Panel Signal Outputs Optional

COMMON CHARACTERISTICS
FOR 5100 SERIES
UNLESS OTHERWISE SPECIFIED

VERTICAL SYSTEM

Channels — Left and center plug-in compartments compatible with all 5100 Series plug-ins.

Deflection Factor — Determined by plug-in.

Bandwidth — 2 MHz, determined by plug-in.

Chopped Mode — (5110/R5110, 5111A/R5111A, 5116) The mainframe vertical amplifier will chop between left and center plug-in compartments, and/or between two or more amplifier channels. The total time segment per channel is ≈5 μs, consisting of ≈4 μs displayed, ≈1 μs blanked. Chop or alternate mode is selected at the time base unit.

Chopped Mode — (5113/R5113) The left and right mainframe vertical amplifiers are dedicated to the left and center plug-in compartments. Each mainframe vertical amplifier will chop between two or more channels in their associated plug-in compartments. No channel switching is necessary between left and center plug-in compartments. The total time segment per channel is ≈5 μs, consisting of 4 μs displayed, ≈1 μs blanked. Chop or alternate mode is selected at the time base unit.

Alternate Mode — (5110/R5110, 5111A/R5111A, 5116) Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before switching to the second amplifier.

Alternate Mode — (5113/R5113) Single-trace amplifiers are swept full time. Each channel of a multitrace amplifier is swept once before switching to the next channel. No channel switching is necessary between left and center plug-in compartments.

HORIZONTAL SYSTEM

Channel — Right-hand plug-in compartment compatible with all 5100 Series Plug-ins.

Fastest Calibrated Sweep Rate — 0.1 μs/div (X10 mag) with 5B10N or 5B12N.

X-Y Mode — Phase shift within 1° from dc to 100 kHz.

OTHER CHARACTERISTICS

Ambient Temperature — 5110, 5111A, 5113: Performance characteristics valid from 0°C + 50°C. 5116/R5116: Performance characteristics valid from 0°C to +45°C.

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10% (except that maximum input should not exceed 250 V ac). Internally selected with quick change jumpers.

Line Frequency Range — 48 Hz to 440 Hz.

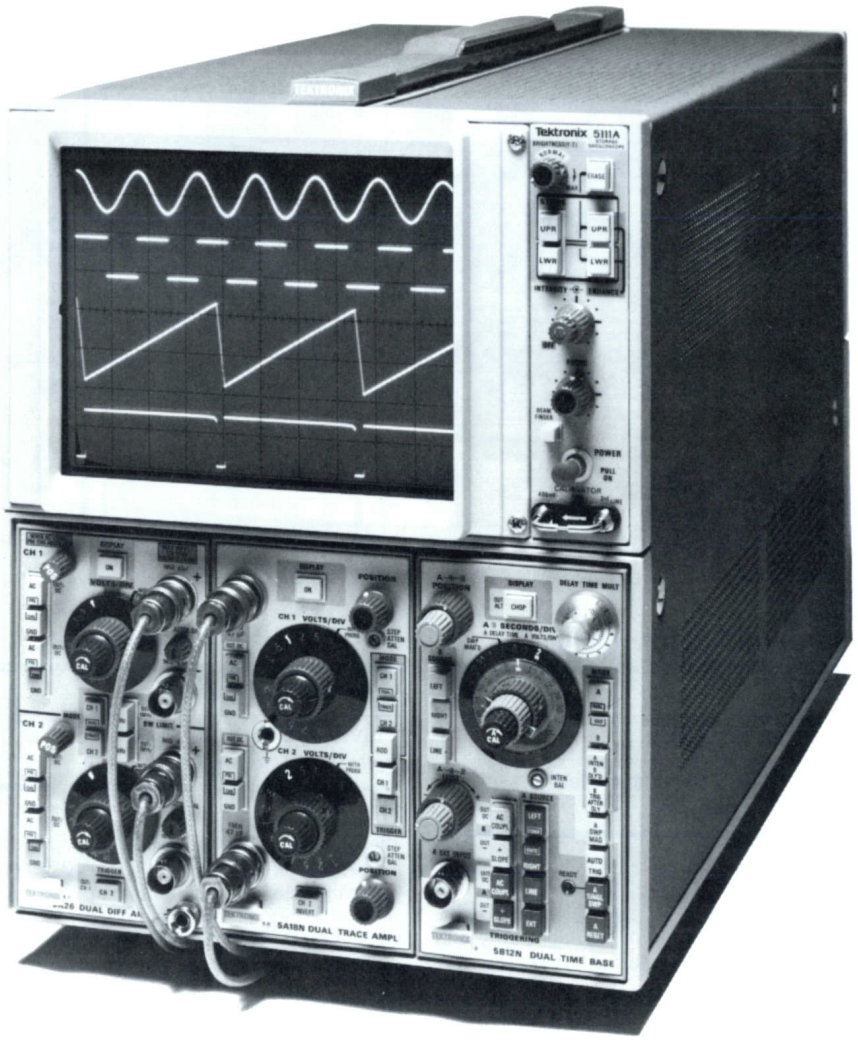
Maximum Power Consumption — 110 W.

External Intensity Input — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range dc to 1 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input ±50 V (dc + peak ac.)

Calibrator — Voltage output 400 mV within 1%. Current output (loop) 4 mA within 1%. Frequency is 2 times line frequency.

Beam Finder — Positions beam on screen regardless of vertical and horizontal position control settings.

Included Accessory — Instruction manual.



5111A/R5111A

Single-Beam Storage Oscilloscope

Bistable, Split-Screen Display

Stored Writing Speed
20 divs/ms in Normal Mode
50 divs/ms in Enhanced Mode
or
200 divs/ms in Normal Mode
800 divs/ms in Enhanced Mode with Option 03

The 5111A incorporates the time proven features of the 5111 plus improvements that futher extend the usefulness of this popular instrument.

In addition to the normal storage function, the 5111A incorporates an Enhanced Mode which extends the stored writing speed to 50 div/ms.

For those applications where even greater stored writing speed is needed, we offer Option 03, Fast Writing Speed CRT. Option 03 provides ten times the standard stored writing speed at lower stored brightness.

Other features for the 5111A include a detachable power cord and international power cord and plug options.

The 5111A is a single-beam, split-screen, bistable oscilloscope with a large-screen, 6½ in diagonal (1.27 cm/div) display.

The 5111A extends measurement capability into areas requiring retention of single and multitrace displays for long-term examination and/or photography. It is particularly useful for recording low and medium speed displays like those found in semi-conductor curve tracing, sampling, vibration analysis, and the biophysical sciences.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

CHARACTERISTICS

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (1.27 cm/div) parallax-free, nonilluminated graticule.*1

Accelerating Potential — 3.5 kV.

Phosphor — Equivalent to GJ (P1).

Maximum Stored Writing Speed — At least 20 div/ms in the Normal Mode and 50 div/ms in the Enhanced Mode.

With Option 03, Fast Writing Speed CRT — At least 200 div/ms (center 6 x 8 div) in the Normal Mode and 800 divs/ms (center 6 x 8 div) in the Enhanced Mode.*1

Storage View Time — At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

Erase Time — ≈250 ms.

**1 Illuminated graticule available at extra cost.*

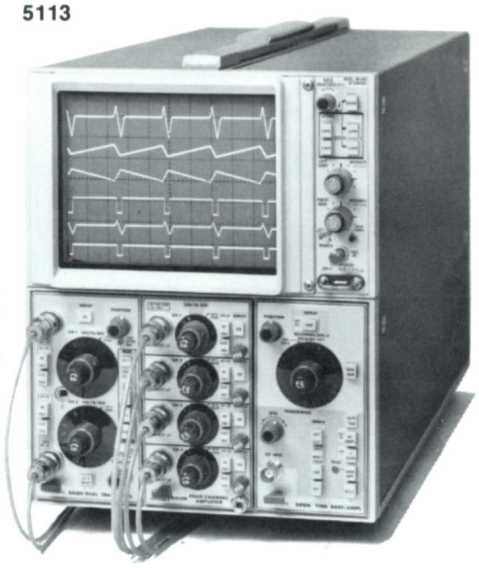
INCLUDED ACCESSORIES

Power cord (161-0066-00); instruction manual.

5110

Single Beam

5113



Dual-Beam Bistable Storage

5110/R5110

Lowest Cost Single-Beam Nonstorage Oscilloscope with Plug-in Configurability

8 Channels at 1 mV/div, 4 Channels at 50 μV/div, 2 Channels at 10 μV/div, with Appropriate Amplifiers

The 5110 is a single-beam nonstorage oscilloscope featuring a large diagonal 6.5 inch (1.27 cm/div) CRT.

Tailor your measurement needs with the appropriate plug-in units to obtain high-gain differential (10 μV/div), four channel differential at 50 μV/div, eight-channel displays at 1 mV/div. Or choose from our extra low cost basic amplifier and time-base plug-ins to suit the special needs of education and industry.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.*1

Accelerating Potential — 3.5 kV.

Phosphor — GH (P31) standard, GM (P7) or BE (P11) optional.

*1 *Illuminated graticule available at extra cost.*

CRT Readout as shown above, is generated via the 5D10 Waveform Digitzer, described on page 293.

5113/R5113

Dual-Beam Bistable Storage Oscilloscope

Two Independent Vertical Systems

Two Single-Shot Display Signals without Timesharing, or up to Eight Signals in the Chop Mode

Split-Screen Storage

Stored Writing Speed ⩾20 div/ms

The 5113 is a dual-beam bistable storage oscilloscope featuring easy-to-use split-screen storage. Stored writing speed is at least 20 div/ms. View time is at least one hour at normal intensity and can be increased to ten hours at reduced intensity.

The 5113 can display two simultaneous events, either single-shot or repetitive, against a common time base within the bandwidth and writing rate limits of the system. Both beams are driven by one set of horizontal deflection plates.

The 5113 is particularly useful in biomedical research where low-repetition-rate stimulus/response potentials need to be observed and recorded.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.*1

Accelerating Potential — 3.5 kV.

Phosphor — Similar to GJ (P1).

Maximum Stored Writing Speed — At least 20 div/ms.

Storage View Time — At least one hour at normal intensity; up to ten hours at reduced intensity, after which time it may be increased to original level.

Erase Time — ≈250 ms.

*1 *Illuminated graticule available at extra cost.*

OPTION 07: 5100 SERIES

REAR PANEL SIGNAL OUTPUTS

Left and Center Compartments — Two BNC connectors provide access to the CRT related signals from the left and center plug-in amplifiers. Sensitivity: 0.5 V/CRT division. Output impedance: 1 kΩ.

Right Compartment — Sweep: One BNC connector provides access to the CRT-related sweep waveform. Sensitivity is 0.5 V/CRT division; positive-going sawtooth, ⩾5 V. Output Impedance is 1 kΩ. Gate: One BNC connector provides access to TTL compatible gate. Positive-going, coincident with displayed sweep.

X-Y Mode — CRT-related X-Y signals are available at the appropriate rear panel connectors when amplifier plug-ins are used in either the left or center compartment and the right compartment to display X-Y information. Sensitivity (X-Y): 0.5 V/CRT division.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

Cabinet Models

5110 Oscilloscope **$1,505**
5111A Oscilloscope **$2,430**
5113 Oscilloscope **$3,535**

Rackmount Models

R5110 Oscilloscope **$1,560**
R5111A Oscilloscope **$2,480**
R5113 Oscilloscope **$3,585**

Option 02 — Protective Panel Cover (Cabinet Models Only). The cover protects the front panel and knobs during transportation and storage. ..... **+$25**
Option 03 — Fast Write CRT (5111A/R5111A Only). Increases stored writing speed to 200 div/ms (center 6 x 8 div). ..... **+$150**
Option 03 — Fast Write CRT (5113/R5113 Only) Increases stored writing speed to 200 div/ms (center 6 x 8 div). ..... **+$150**
Option 07 — Add Rear Panel Signals Out (All Models) ..... **+$75**
Option 76 — GM (P7) Phosphor (5110, R5110 Only) .. **+$50**
Option 78 — BE (P11) Phosphor (5110, R5110 Only) . **+$50**

CONVERSION KITS

Cabinet-to-Rackmount Conversion Kit — Order 040-0583-03 ..... **$95**
Rackmount-to-Cabinet Conversion Kit — Order 040-0584-04 ..... **$150**
Protective Panel Cover Kit — Order 040-0620-00 ..... **$40**
Rear Panel Signal Outputs Conversion Kit (Option 07) — Order 040-0915-02 ..... **$205**

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 , 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

For recommended cameras refer to camera section.

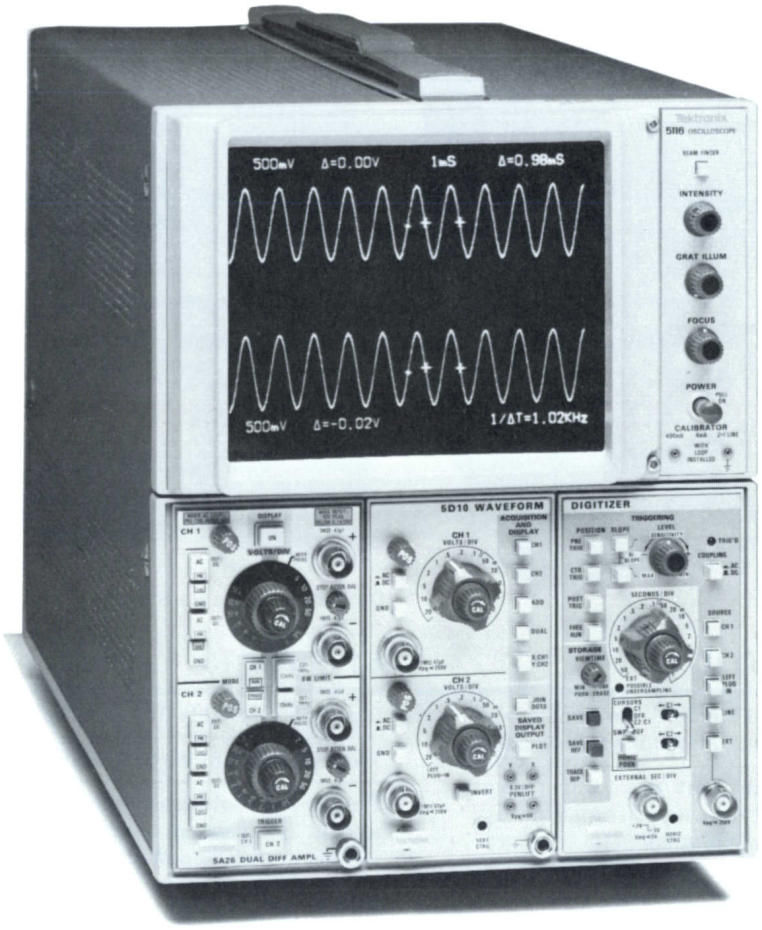
NEW

5116

Three Color, High Resolution Digital Storage Display with 5D10

Convergence Not Required, Single Beam Design

Accepts Full Range of 5100 Series Amplifiers for Preconditioning or Noncolor Applications



The 5116 Oscilloscope is a new low-cost, single-beam scope which offers the modularity and flexibility of Tek's popular 5000 Series oscilloscopes. When used with a Tektronix 5D10 Waveform Digitizer*[1], it provides a unique three-color display in addition to the digital storage capabilities and features of the 5D10.

Color enhances individual trace and readout identification, thereby providing a much improved user interface. The coding capabilities afforded by color allow for interpretation and differentation of data more quickly, reduced measurement errors, and improved resolution by using the full screen for overlapping signals.

Permanent records are made with either a camera or with the 5D10 Waveform Digitizer plotter output.

Left vertical plug-in may be used to precondition up to two signals for Channel 2 of the 5D10. For example, plug-ins such as the 5A21N, 5A22N and 5A26 can provide differential performance with sensitivities ranging to 10 μV/div (5A22N). The 5D10 can acquire a total of three signal channels when using the Channel 2 left plug-in acquisition feature. The left vertical plug-in can also be used without the acquisition feature of the 5D10 to view a signal directly from the amplifier.

When used in noncolor applications, a wide variety of 5000 Series plug-ins are available to tailor your system for specific applications. These plug-in units range from high gain differential (10 μV/div), four channel differential (50 μV/div), eight channel (1 mV/div) amplifiers, plus economical basic amplifiers and time base plug-in units.

CHARACTERISTICS

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (1.27 cm/div) parallax-free, illuminated graticule.

Accelerating Potential — 4.5 kV.

Color Shutter — With 5D10*[1]: Three-color display of blue-green, orange, and neutral. Without 5D10: Blue-green display.

*[1] *Three-color display requires a 5D10 with serial number B020000 or higher. A field installable kit is available to upgrade earlier 5D10's. Contact your local Tektronix representative for details.*

VERTICAL SYSTEM

Channels — Left and center plug-in compartments compatible with all 5100 Series plug-ins. Center and right plug-in compartments accept the 5D10 Waveform Digitizer for dual-trace color and digital storage of displays.

Chopped Mode — The mainframe vertical amplifier will chop between left and center plug-in compartments, and/or between two or more amplifier channels. The time segment per channel is ≈5 μs, consisting of ≈4 μs displayed, ≈1 μs blanked. Chop or alternate mode is selected at the time base unit.

Alternate Mode — Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before switching to the second amplifier.

HORIZONTAL SYSTEM

Channel — Right-hand plug-in compartment compatible with all 5100 Series plug-ins. The 5D10 utilizes the center and right-hand compartments for dual trace color and digital storage of displays.

Fastest Calibrated Sweep Rate — With 5D10; 0.1 ms/div. With 5B10N or 5B12N: 0.1 μs/div (X10 mag).

X-Y Mode — Phase shift within 1° from dc to 100 kHz.

OTHER CHARACTERISTICS

Ambient Temperature — Performance characteristics valid from 0°C to +45°C.

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10% (except that maximum input should not exceed 250 V ac). Internally selected with quick change jumpers.

Line Frequency Range — 48 Hz to 440 Hz.

Maximum Power Consumption — 110 W.

External Intensity Input — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range dc to 1 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input ±50 V (dc + peak ac.)

Calibrator — Voltage output 400 mV within 1%. Current output (loop) 4 mA within 1%. Frequency is 2 times line frequency.

Beam Finder — Positions beam on screen regardless of vertical and horizontal position control settings.

OPTION 07
REAR PANEL SIGNAL OUTPUTS

Left and Center Compartments — Two BNC connectors provide access to the CRT related signals from the left and center plug-in amplifiers. Sensitivity: 0.5 V/CRT division. Output Impedance: 1 kΩ.

Right Compartment — Sweep: One BNC connector provides access to the CRT-related sweep waveform. Sensitivity is 0.5 V/CRT division; positive-going sawtooth, ≥5 V. Output Impedance: 1 kΩ. Gate: One BNC connector provides access to TTL compatible gate. Positive-going, coincident with displayed sweep.

X-Y Mode — CRT-related X-Y signals are available at the appropriate rear panel connectors when amplifier plug-ins are used in either the left or center compartment and the right compartment to display X-Y information. Sensitivity (X-Y): 0.5 V/CRT division.

INCLUDED ACCESSORIES

Power cord (161-0066-00); instruction manual.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

5116 Oscilloscope **$2,335**

Option 02 — Protective Panel Cover (Cabinet Models Only).The cover protects the front panel and knobs during transportation and storage ..... **+$25**

Option 07 — Add Rear Panel Signals Out (both models) ..... **+$75**

CONVERSION KITS

Cabinet-to-Rackmount Conversion Kit
Order 040-0583-03 ..... **$95**

Rackmount-to-Cabinet Conversion Kit
Order 040-0584-04 ..... **$150**

Protective Panel Cover Kit
Order 040-0620-00 ..... **$160**

Rear Panel Signal Outputs Conversion Kit (Option 07)
Order 040-0915-02 ..... **$250**

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 , 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

For 5D10 Waveform Digitizer see next page.

For recommended cameras refer to camera section.
See this color product in the reference section beginning on page 9.

5D10

Compatible with all 5000 Series Mainframes

Digital Storage

CRT Readout

Powerful Triggering Capability

1% Accuracy

Dual Channel

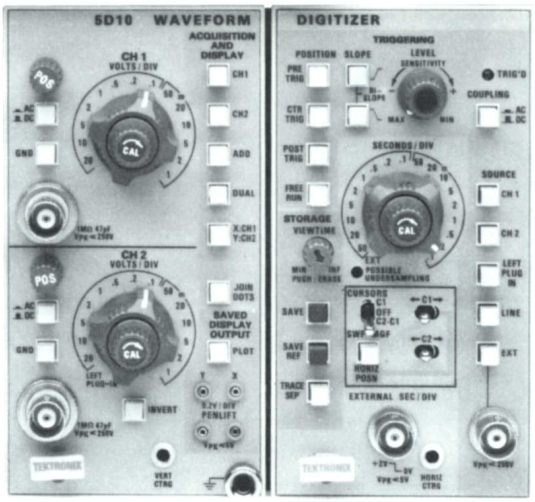
1 MHz Sample Frequency

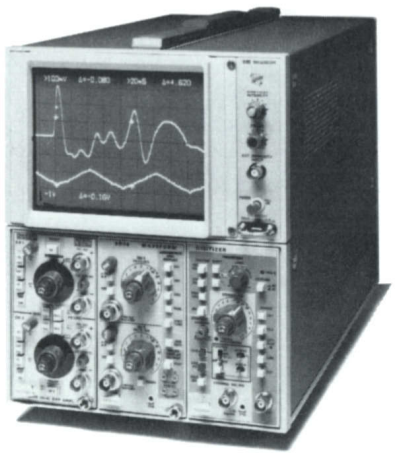
Save Reference Waveforms

X-Y Recorder Output

Signal Conditioning Via Left Vertical Plug-In

Color Signal Source for 5116 Oscilloscope





5D10 and 5A26 installed in a 5110 Mainframe

The 5D10 enhances all Tektronix 5000 Series mainframes by providing storage for transient events with frequency components up to 100 kHz for a single channel acquisition and up to 50 kHz for dual channel acquisition, all in a compact two-wide plug-in.

Together, the 5D10 and the Tektronix 5116 Oscilloscope create a system of high resolution color*[1] and waveform digitizing for superior trace and readout clarity.

The digital storage characteristics of the high performance 5D10 duplicate CRT storage features and provide the following additional features:

Digital Storage
Provides clear, crisp, bright displays which can be viewed indefinitely.

Cursors
Permit convenient single-point and point-to-point measurement of time, amplitude, and frequency for fast, accurate, and reliable answers.

CRT Readout
Displays all pertinent instrument settings, cursors, and waveform levels. Lets you read out complete operational status at a glance.

Pretrigger
Allows viewing information prior to the trigger event so you can see all your data. Center and posttrigger selection is also provided.

Free Run
Optimizes the data presentation for low speed phenomena, much like a stripchart recorder.

1% Accuracy
Improves measurement quality in both vertical and horizontal modes.

Dual Samplers
Ensures time coincidence between the two input channels.

Bi-Slope Triggering
Assures triggering when the slope of a transient event is not known.

**[1] Three-color display requires a 5D10 with serial number B020000 or higher. A field installable kit is available to upgrade earlier 5D10's. Contact your local Tektronix representative for details.*

1 MHz Sample Frequency
Stores single-shot events to approximately 100 kHz in bandwidth with 8-bit vertical resolution.

Storage View-Time
Convenient view time control from 1 second to infinity.

Save Reference
Permits comparisons of signals stored at different times.

X-Y Displays
Provides less than 1° phase shift up to 100 kHz of parametric related signals.

X-Y Recorder Output
Provides inexpensive, archivable hard copies complete with readout, graticule, and displayed waveforms in full color.

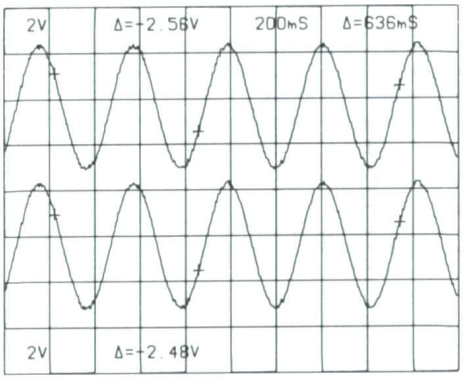
Left Vertical Plug-in
May be used to precondition up to two signals for Channel 2 of the 5D10 (when used in 5100 Series mainframes only).

For example, plug-ins such as the 5A21N, 5A22N and 5A26 can provide differential performance with sensitivities ranging to 10 μV/div (5A22N). The 5D10 can acquire a total of three signal channels when using the Channel 2 left plug-in acquisition feature.

CHARACTERISTICS

VERTICAL

Vertical Modes — CH 1, CH 2, Add, Dual, X-Y.
Channel 2 Modes — V/div, Left plug in.
Deflection Factor — 1 mV/div to 20 V/div in 14 calibrated steps (1-2-5 sequence).
Accuracy — Input to Readout Numbers: 5 mV/div to 1 V/div ±1%; 1 mV/div to 2 mV/div ±2%; 2 V/div to 20 V/div ±2%; Input to CRT graticule ±2%. From Left Vertical Plug-in: Add ±1% to above specifications. Add Mode: Add ±1% to above specifications.
Input R and C — 1 MΩ ±0.5% paralled by ≈47 pF.
Maximum Input — 250 V (dc + peak ac); 250 V p-p ac at 1 kHz or less.
Bandwidth — Single Channel: Suitable from dc to 100 kHz. Dual Channel: Suitable from dc to 50 kHz. Ac Coupling: 3 dB point—10 Hz or less (1 Hz with 10X probe).
Common-Mode Rejection — At least 50:1, dc to 100 kHz.



Example of plotter waveforms with graticule scaling information

Resolution — Vertical: X-Y or Y-T; 0.04 div (8-bit digitzer). Horizontal: Y-T; 0.01 div (1024 memory locations shared among all traces displayed).
Phase Shift — ≤1.0° phase shift between CH 1 and CH 2, dc to 100 kHz.
Display Output (to X-Y Recorder) — Amplitude: 0.2 V/div ±2%. Speed: Compatible with X-Y recorders with 20 in/s slew rate, or faster. Pen Lift: Isolated switch contacts, SPST (floating); normally open or normally closed selected by internal jumper.

TIME BASE

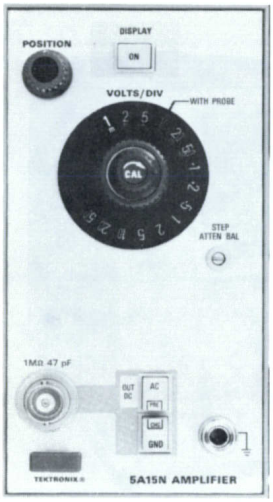
Sweep Rates — 0.1 ms to 50 s/div in 18 calibrated steps 1-2-5 sequence.
Accuracy — Within ±1% of readout numbers.
External Input — Allows external pulse generator to determine acquisition rate. Accepts TTL levels up to 1 MHz rate.
Possible Under-Sampling Indicator — Indicator lights when fewer than eight sample pulses occur during interval between successive threshold crossing of triggering signals.

TRIGGERING

Sources — CH 1, CH 2, left plug-in (via mainframe), line, external.
Coupling — Dc, ac.
Sensitivity — External: 100 mV; dc to 50 kHz or pulsewidth >5 μs; 250 mV 50 kHz to 250 kHz or pulsewidth >1 μs. CH 1, CH 2, Left Plug-in: 0.4 div, dc to 50 kHz or pulsewidth >5 μs; 1.0 div, 50 kHz to 250 kHz or pulsewidth >1 μs.
Bi-Slope Trigger — Amplitude, frequency, and pulsewidth specifications apply to absolute value of signal (rectified).
External Trigger Input — Input R and C: 1 MΩ ±2% paralleled by ≈47 pF. Maximum input 250 V (dc + peak ac). 250 V p-p ac at 1 kHz or less.
Included Accessory — Instruction manual.

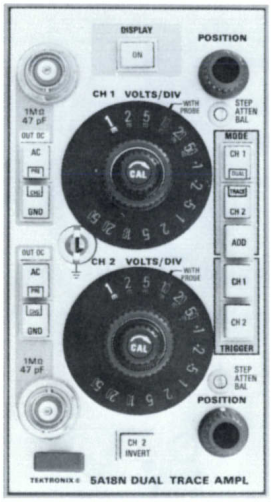
Order 5D10 Waveform Digitizer **$2,850**

5A15N



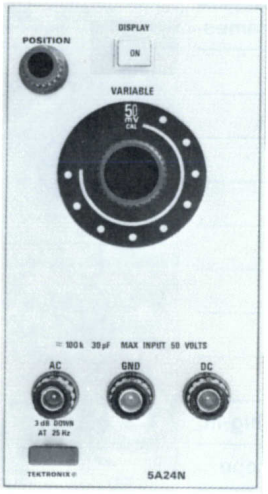
Single Trace Dc to 2 MHz

5A18N



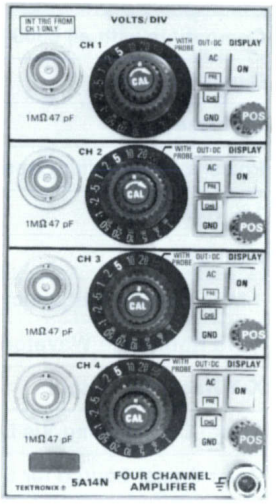
Dual Trace Dc to 2 MHz

5A24N



Single Trace Dc to 2 MHz

5A14N



Four Trace Dc to 1 MHz

5A15N Amplifier

1 mV/div to 5 V/div

The 5A15N Single Trace Amplifier features easy to use front-panel controls and can be used in many 5000 Series mainframe.

Two 5A15Ns (one must be located in the right-hand compartment) provide versatile X-Y operation when used in a 5100 Series Mainframe.

CHARACTERISTICS

Bandwidth — Dc Coupled: Dc to at least 1 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factor — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy: Within 2%. Uncalibrated: Continuously variable between calibrated steps and to 12.5 V/div.

Input R and C — 1 MΩ within 1% paralleled by ≈47 pF.

Maximum Input — Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V dc.

Included Accessory — Instruction manual.

5A18N Amplifier

1 mV/div to 5 V/div

The 5A18N Dual Trace Amplifier features easy to use front-panel controls and can be used in any 5000 Series mainframe.

5A18N operating modes include Channel 1 or 2 only, Channels 1 and 2 added, Channel 2 inverted, and Channel 1 alternated or chopped with Channel 2. Internal trigger source is selectable from Channel 1 and Channel 2.

CHARACTERISTICS

Bandwidth — Dc Coupled: dc to at least 2 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factor — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy: Within 2%. Uncalibrated: Continuously variable between calibrated steps and to 12.5 V/div.

Input R and C — 1 MΩ within 1% paralleled by ≈47 pF.

Maximum Input — Dc Coupled: 350 V (dc + peak ac). Ac-Coupled: 350 V dc.

Chopping Rate — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

Included Accessory — Instruction manual.

5A24N Amplifier

50 mV/div to 1 V/div Deflection Factors

Easy to Customize

The 5A24N is a low cost utility plug-in providing direct access to either the vertical or horizontal deflection system of the 5000 Series mainframes. It contains mode switching, CRT beam positioning, trigger pickoff for basic measurements, and a built-in 3⅜ x 2¾ inch soldering pad matrix for use by the customers who wish to build their own input circuits for special applications. Customer-built circuits are powered through the circuit board which provides access to all mainframe power supplies.

CHARACTERISTICS

Bandwidth — Dc Coupled: Dc to at least 2 MHz at 50 mV/div, decreasing to dc to 200 kHz at mid-attenuator range. Ac Coupled: 25 Hz to at least 2 MHz at 50 mV/div, decreasing to 25 Hz to 200 kHz at mid-attenuator range. Uncompensated input.

Deflection Factor — Compensated: 50 mV/div, accurate within 3%. Uncompensated: Continuously variable from 50 mV/div to at least 1 V/div.

Input R and C — ≈100 kΩ paralleled by ≈30 pF.

Maximum Input — 50 V (dc + peak ac).

Included Accessory — Instruction manual.

5A14N Amplifier

1 mV/div to 5 V/div

The 5A14N Four Trace Amplifier features simplified front-panel controls and can be used in any 5000 Series mainframe.

5A14N operating modes are: Each channel separately, and alternated or chopped between any combination of channels. Internal trigger is available from Channel 1 only.

CHARACTERISTICS

Bandwidth — Dc Coupled: Dc to at least 1 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 1 MHz at all deflection factors.

Deflection Factor — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy: Within 2%. Uncalibrated: Continuously variable between calibrated steps and 12.5 V/div.

Input R and C — 1 MΩ within 1% paralleled by ≈47 pF.

Maximum Input — Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V dc.

Chopping Rate — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

Included Accessory — Instruction manual.

ORDERING INFORMATION

5A14N Four Trace Amplifier	**$1,465**
5A15N Single Trace Amplifier	**$350**
5A18N Dual Trace Amplifier	**$730**
5A24N Single Trace Amplifier	**$225**

For recommended probes — refer to page 285.

5A13N

Dc to 2 MHz Bandwidth

1 mV/div to 5 V/div

10,000:1 CMRR

10,000 Div Effective Screen Height

The 5A13N is a differential comparator plug-in amplifier for the 5000 Series. It incorporates a number of performance features that make it particularly versatile.

Conventional Mode

The 5A13N has constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable at 2 MHz or 10 kHz for best displayed noise conditions during low-frequency applications. The plus or minus inputs allow normal or inverted displays.

Differential Mode

The 5A13N maintains its conventional features and provides a balanced input for applications requiring rejection of a common-mode signal. The CMRR is 10,000:1 from dc to 20 kHz, decreasing to 100:1 at 2 MHz. The unit rejects up to 15 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 350 V rejection capability above 100 mV/div.

Comparator Mode

The 5A13N provides an accurate positive or negative internal offsetting voltage. A signal of up to ±10 V may be applied to an input (plus or minus) at a deflection factor setting of 1 mV/div and viewed in 10,000 div by offsetting the signal with the opposing comparison voltage. A ±1 V comparison voltage is also available for applications requiring maximum resolution. The offset voltage may be externally monitored through a front-panel output.

CHARACTERISTICS

Bandwidth — Dc to 2 MHz. Bandwidth Limit Mode: Dc to 10 kHz. Ac Coupled: 2 Hz or less at the lower −3 dB point.

Deflection Factor — Calibrated: 1 mV/div to 5 V/div in a 1-2-5 sequence. Accuracy: Within 3%. Uncalibrated: Continuously variable between steps and to at least 12.5 V/div.

Input R and C — 1 MΩ paralleled by ≈51 pF.

Signal Range

Deflection Factor Settings	1 mV to 50 mV/div	0.1 V to 5 V/div
Common-Mode Signal Range	±10 V	±350 V
Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	±350 V	
Max Ac Coupled Input (Dc Voltage)	±350 V	

Maximum Input Gate Current — 0.1 nA or less (equivalent to 100 μV or less, depending on external loading) at +25°C.

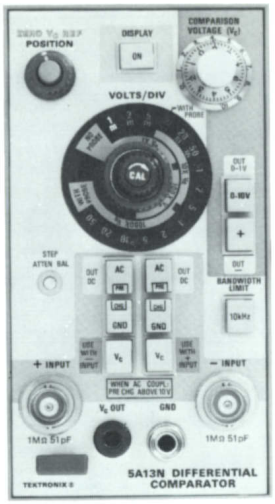
Overdrive Recovery — 1 μs to recover to within 3.0 mV and 0.1 ms to recover to within 1.5 mV after removal of an overdrive signal between +10 V and −10 V, regardless of overdrive signal duration.

Internal Comparison Voltage — Ranges: 0 V to ±10 V and 0 V to ±1 V. Accuracy: Within 0.2% of dial setting plus 5 mV from ±1 V to ±10 V; within 0.2% of dial setting plus 1 mV from ±25 mV to ±1 V on the 0 V to ±1 V range. From 0 V to ±25 mV: Use the on-screen display for greater resolution. Vc Output R: ≈15 kΩ.

Common-Mode Rejection Ratio — At least 10,000:1, dc to 10 kHz at 1 mV/div to 50 mV/div dc coupled, with up to 20 V p-p sine wave, decreasing to 100:1 at 1 MHz. At least 400:1, dc to 10 kHz at 0.1 V/div to 5 V/div dc coupled, with up to 100 V p-p sine wave, decreasing to 40:1 at 1 MHz. For frequencies above 5 kHz ac coupled, CMRR is the same as stated for dc coupled. Below 5 kHz ac coupled, CMRR decreases to 400:1 at 10 Hz.

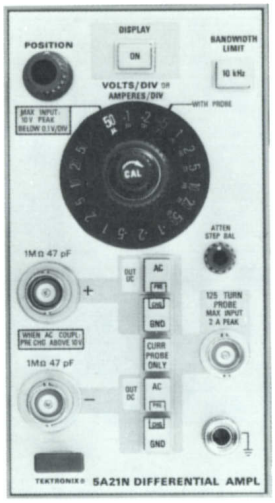
Included Accessory — Instruction manual.

5A13N



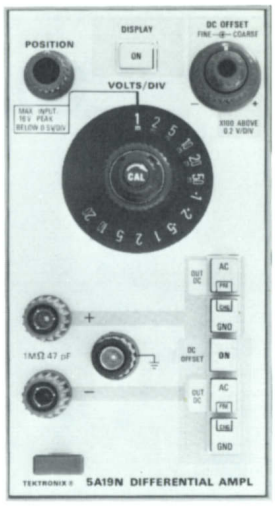
Differential Comparator

5A21N



Differential

5A19N



Differential

5A21N

Dc to 1 MHz Bandwidth

10 kHz Bandwidth Limiter

50 μV/div to 5 V/div

100,000:1 CMRR

Voltage and Current Probe Inputs

The 5A21N is a 50 μV/div, dc coupled differential amplifier for the 5000 Series and has a current probe input.

CHARACTERISTICS

Bandwidth — Dc Coupled: dc to at least 1 MHz. Ac Coupled: 2 Hz less at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor — Calibrated: 50 μV/div to 5 V/div in 16 steps (1-2-5 sequence). Accuracy: Within 2%. Uncalibrated: Continuously variable between steps and to 12.5 V/div.

Input R and C — Voltage Mode: 1 MΩ within 0.15% paralleled by ≈47 pF.

Maximum Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	350 V dc (coupling cap precharged), 10 V peak ac
10 mV/div to 5 V/div	350 V (dc + peak ac)	

Input Gate Current — 100 pA or less (equivalent to 100 μV or less, depending on external loading, at +25°C.

Displayed Noise — 30 μV or less, tangentially measured.

Common-Mode Rejection Ratio — Ac Coupled: 50 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above decreasing to 400:1 at 10 Hz. Dc Coupled: at least 100,000:1 dc to 30 kHz at 50 μV/div and 100 μV/div with up to 20 V p-p sine wave, decreasing by <20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V p-p sine wave.

CURRENT PROBE INPUT (with P6021 CURRENT PROBE)

Bandwidth — 15 Hz or less, to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor — Calibrated: 0.5 mA/div to 0.5 A/div in 10 steps (1-2-5 sequence). Accuracy: Within 3%. Uncalibrated: Continuously variable between steps and to 1.25 A/div.

Maximum Input Current — 4 A p-p (at probe loop) with 125-turn P6021 Current Probe.

Displayed Noise — 300 μA or less, tangentially measured. Performance characteristics are valid for the 5A21N from 0°C to +50°C.

Included Accessory — Instruction manual.

High CMRR Probes for Differential Amplifiers

We recommend the P6055 high CMRR adjustable 10X probes for use with Tektronix differential amplifiers. When used in pairs, these probes allow adjustment for maximum CMRR. See page 455.

For recommended probes — refer to page 285.

5A19N

Dc to 2 MHz Bandwidth

1 mV/div to 20 V/div

Dc Offset

The 5A19N is a low-cost differential amplifier featuring variable dc offset and simplicity of controls. It is ideal for monitor and systems applications. It operates in the left or middle plug-in compartment of the 5000 Series mainframe for Y-T displays, or in the right compartment for X-Y displays.

CHARACTERISTICS

Bandwidth — Dc Coupled: dc to at least 2 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factor — Calibrated: 1 mV/div to 20 V/div in a 1-2-5 sequence. Accuracy: Within 2%. Uncalibrated: Continuously variable between calibrated steps and to 50 V/div.

Input R and C — 1 MΩ within 0.3% paralleled by ≈47 pF.

Signal and Offset Range

Deflection Factor Settings	1 mV/div to 200 mV/div	500 mV/div to 20 V/div
Common-Mode Signal Range	±16 V	±350 V
Maximum Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	±350 V	
Maximum Ac Coupled Input (Ac Voltage)	±350 V	
Dc Off Set Range	+15 V to −15 V	+350 V to −350 V

Common-Mode Rejection Ratio — Dc Coupled: 1 mV/div to 200 mV/div, at least 1000:1 from dc to 10 kHz; decreasing to 100:1 at 500 mV/div to 20 V/div.

Included Accessory — Instruction manual.

ORDERING INFORMATION

5A13N Differential Comparator Amplifier **$1,375**

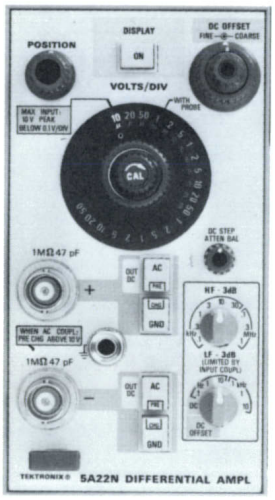
5A19N Differential Amplifier **$430**

5A21N Differential Amplifier **$540**

Option 01 — (includes P6021, 5 ft current probe) ..... **+$290**

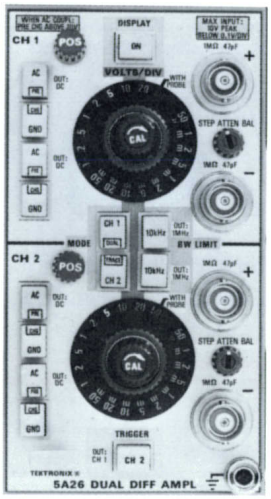
The 5A21N and 5A22N Differential Amplifiers are available with CRT readout at additional cost (CRT readout functional in 5400 Series mainframes only). Contact your local Tektronix Sales Engineer for details.

5A22N



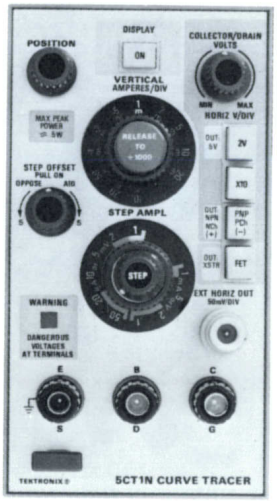
Differential Amplifier

5A26



Dual Differential Amplifier

5CT1N



Curve Tracer

5A22N

Dc to 1 MHz Bandwidth

10 μV/div to 5 V/div

100,000:1 CMRR

Selectable Upper and Lower −3 dB Points

Dc Offset

The 5A22N is the most versatile of the 5000 Series Differential Amplifiers. It features front panel selectable filtering which enables reduction of undesirable displayed noise; both upper and lower 3 dB points are selectable. Dc offset at full bandwidth is available for viewing signals riding on a dc component such as low-level ripple and noise on a power supply.

These features, together with its high common-mode rejection, make the 5A22N well suited for measurements in difficult low-amplitude, low-frequency areas.

CHARACTERISTICS

Bandwidth — HF −3 dB Point: Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. 100 Hz to 0.3 MHz, accurate to within 20% of selected frequency; at 1 MHz, bandwidth is down 3 dB or less. LF −3 dB Point: Selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz accurate to within 20% of selected frequency. Ac Coupled: 2 Hz or less.

Deflection Factor — Calibrated: 10 μV/div to 5 V/div in a 1-2-5 sequence. Accuracy: Within 3%. Uncalibrated: Continuously variable between steps and to at least 12.5 V/div.

Common-Mode Rejection Ratio — Ac Coupled: 10 μV/div to 0.5 mV/div, at least 20,000: 1 at 5 kHz and above, decreasing to 400:1 at 10 Hz. Dc Coupled: at least 100,000:1, dc to 30 kHz from 10 μV/div to 100 μV/div with up to 20 V p-p sinewave, decreasing by <20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V p-p sinewave.

Signal and Offset Range

Deflection Factor Settings	10 μV to 50 mV/div	0.1 V to 5 V/div
Common-Mode Signal Range	±10 V	-350 V
Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	±12 V	±350 V
Max Ac Coupled Input (Dc Voltage)	±350 V Dc rejection, at least 4 x 10^5:1	
Dc Offset Range	+0.5 V to −0.5 V	+50 V to −50 V

Input R and C — 1 MΩ within 0.15% paralleled by ≈47 pF.

Overdrive Recovery — 10 μs or less to recover within 99.5% of reference level after removal of a test signal applied for 1 s. Signal amplitude not to exceed common-mode signal range.

Maximum Input Gate Current — 200 pA or less.

Displayed Noise — 20 μV at maximum bandwidth, source resistance 25 Ω or less, measured tangentially.

Drift with Temperature — 100 μV/°C or less.

Included Accessory — Instruction manual.

5A26

Two Differential Amplifiers in One Plug-In

50 μV/div Sensitivity at 1 MHz

100,000: 1 CMRR

CRT Readout

The 5A26 Dual Differential Amplifier combines two independent differential amplifiers in one plug-in. It adds no-compromise differential measurement capability to the line of low-cost, high-performance 5000 Series Laboratory Oscilloscopes. It may be used in any 5000 Series mainframe.

The 5A26 provides 50 μV/div sensitivity at 1 MHz, high common-mode rejection ratio, *CRT readout in any standard 5400 Series mainframe,* trigger-source selection and bandwidth limit on each channel. With two 5A26s, it is possible to observe up to four differential channels at one time in the chop or alternate mode.

The 5A26 has many applications in areas that require dual differential performance, especially in biomedical and electromechanical fields, education, and component manufacturing.

CHARACTERISTICS

Number of Differential Channels — Two.

Bandwidth — Dc Coupled: Dc to at least 1 MHz. Ac Coupled: 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor — Calibrated: 50 μV/div to 5 V/div in 16 steps (1-2-5 sequence). Accuracy: Within 2%. Uncalibrated: Continuously variable between calibrated steps and to 12.5 V/div.

CRT Readout — CRT readout of deflection factors. Functional in CRT readout-equipped 5400 Series oscilloscopes, nonfunctional in 5100 Series oscilloscopes.

Input R and C — 1 MΩ within 0.15% paralleled by ≈47 pF.

MAXIMUM INPUT VOLTAGE

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	10 V ac, 350 V (coupling cap precharged)
100 mV/div to 5 V/div	350 V (dc + peak ac)	350 V (dc + peak ac)

Input Gate Current — 100 pA or less (equivalent to 100 μV or less, depending on external loading) at +25°C.

Displayed Noise — 30 μV or less, tangentially measured.

COMMON-MODE REJECTION RATIO

Dc Coupled	
50 μV/div to 50 mV/div	At least 100,000:1 from dc to 30 kHz with up to 20 V p-p sinewave
100 mV/div to 5 V/div	At least 300:1 from dc to 30 kHz with up to 100 V p-p sinewave
Ac Coupled	
50 μV/div to 50 mV/div	At least 20,000:1 at 5 kHz to 30 kHz, decreasing to not less than 2000:1 at 60 Hz

Included Accessory — Instruction manual.

ORDERING INFORMATION

5A22N Differential Amplifier **$1,080**

5A26 Dual Differential Amplifier **$1,170**

High CMRR Probes for Differential Amplifiers
We recommend the P6055 high CMRR adjustable 10X probes for use with Tektronix differential amplifiers.

When used in pairs, these probes allow adjustment for maximum CMRR.

See page 455 for P6055 characteristics.

5CT1N Curve Tracer

Test Semiconductor Devices to 0.5 W

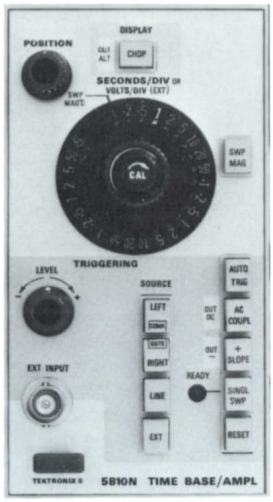
10 nA/div to 20mA/div Vertical Deflection Factors

0.5 V/div to 20 V/div Horizontal Deflection Factors

For a complete description see page 415.

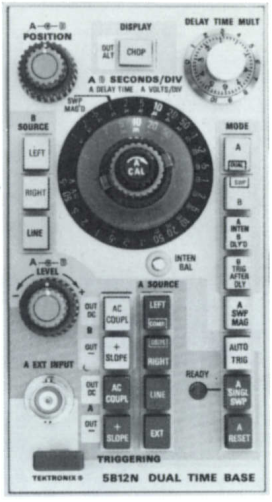
For recommended probes—refer to page 285.

5B10N



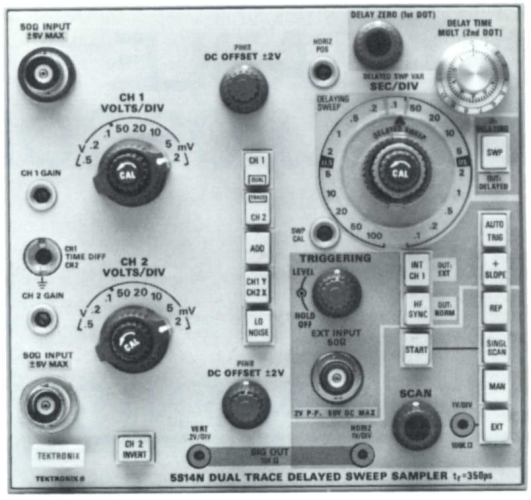
Single Sweep Time Base

5B12N



Dual Sweep Time Base

5S14N



Sampler

5B10N/5B12N

100 ns/div to 5 s/div Calibrated Time Base

Single Sweep

X10 Magnifier

Provides Alternate and Chopped Displays

50 mV/div and 500 mV/div External Input

Dual and Delayed Sweep (5B12N)

The 5B10N is a time base/amplifier plug-in unit for generating a sweep in the 5000 Series oscilloscopes. An external input allows use of the 5B10N as a voltage amplifier with calibrated deflection factors of 50 mV/div and 500 mV/div.

Multiple triggering modes may be pushbutton selected with the 5B10N. Source positions include left or right plug-in, composite (from the mainframe vertical amplifier), line and external.

The 5B12N is a time base for generating single, dual, or delayed sweeps in 5000 Series oscilloscopes. The 5B12N is normally used in the right plug-in compartment but is compatible with the vertical deflection compartments as well.

The 5B12N display modes are A sweep, B sweep, A intensified —B delayed, and dual sweep. Each mode is selectable by pushbutton switches. Triggering sources for A and B sweep include left and right plug-in, line, and display composite. In the display composite mode the sweep is triggered from the composite signal being displayed. Auto and external trigger and single sweep are provided for the A sweep. The B sweep operates in triggered or free-run mode after the delay time.

When operated in the dual-sweep mode in a dual-beam oscilloscope with two amplifier plug-ins, first the A sweep and then the B sweep displays the signals from both amplifiers; four traces will be displayed. Both sweeps are displayed simultaneously in chop mode.

When operated in the dual-sweep mode in a single-beam oscilloscope with two amplifier plug-ins, the A sweep is slaved to the left plug-in and the B sweep is slaved to the right plug-in.

The display mode pushbutton selects chop or alternate time-share switching between vertical plug-ins and amplifier channels. Chop rate is 25 kHz to 100 kHz depending on plug-in combinations and number of traces displayed.

CHARACTERISTICS

The following specifications are the same for the 5B10N and the A sweep of the 5B12N. B sweep specifications are identical except where indicated.

Sweep Rates — Calibrated: 1 μs/div to 5 s/div in 21 steps (1-2-5 sequence). X10 Magnifier extends displayed sweep time/div to 100 ns. Uncalibrated: Continuously variable between steps and to 12.5 s/div. B Sweep: 0.2 μs/div to 0.5 s/div in 20 calibrated steps.

Sweep Accuracy — Unmagnified: Within 3% from 1 μs/div to 1 s/div and within 4% of 2 s/div and 5 s/div. Magnified displays accurate within 1% in addition to specified time base sweep accuracy. B Sweep: Within 3% from 1 μs/div to 0.1 s/div. Within 4% at 0.2 μs/div, and 0.5 s/div, 0.2 s/div, and 0.5 s/div.

Triggering Sensitivity

	Coupling	To 1 MHz	At 2 MHz
Dc	Internal	0.4 div	0.6 div
	External*[1]	200 mV	200 mV
Ac	Requirements increase below 50 Hz		

[1] Does not apply to B sweep.

Auto Trig — Same as above except signal rate requirements are 15 Hz and above.

Single Sweep — Same as for ac and dc coupled.*[1]

External Trigger Input — Maximum Input: 350 V (dc + peak ac). Input R and C: 1 MΩ within 2% paralleled by ≈70 pF. Trigger Level Voltage Range: +5 V to −5 V*[1].

[1] Applies to A trigger only.

EXTERNAL HORIZONTAL MODE

Deflection Factor — Calibrated: 50 mV/div and 500 mV/div. Accuracy: Within 3%. X10 variable extends range to at least 5 V/div.

Bandwidth — Dc Coupled: Dc to at least 1 MHz. Ac Coupled: 50 Hz or less to at least 1 MHz.

Input R and C — 1 MΩ within 2% paralleled by ≈70 pF.

Maximum Input Voltage — 350 V (dc + peak ac).

DELAYING SWEEP (5B12N)

Delay Time — Accuracy: 1 μs/div to 0.5 s/div, within 1%. 1 s/div to 5 s/div, within 2%. Multiplier Range: 0.2 to 10.2 times the time/div setting. Multiplier Incremental Linearity: Within 0.2%.

Differential Time Measurement Accuracy — Within 1% plus 2 minor dial div for 1 μs to 0.5 s delay times. Within 2% plus 2 minor dial div for 1 s to 5 s delay times.

Jitter — <0.05% of the time represented by one div of the delaying sweep selected.

Included Accessory — Instruction manual.

ORDERING INFORMATION

5B10N Time Base/Amplifier **$530**

5B12N Dual Time Base **$1,115**

5S14N

Dc to 1 GHz Bandwidth

Dual Trace, 2 mV/div Sensitivity

Calibrated Delayed Sweep

Simplified Triggering

Operational Ease of Conventional Oscilloscope

Two-Dot Time Measurements

The 5S14N Sampling Unit combines amplifier and time-base functions in one double-width plug-in unit designed to operate in all 5000 Series mainframes. Combining the sampling amplifier and time-base functions in one plug-in enables the 5S14N to provide economy and ease of operation. See page 281 for complete description.

CHARACTERISTICS

AMPLIFIER

Bandwidth — Dc to 1 GHz.

Risetime — 350 ps or less.

Deflection Factor — Calibrated: 2 V/div to 0.5 V/div in 8 steps (1-2-5 sequence). Uncalibrated: Variable between steps by at least 2.5 to 1.

Maximum Input Voltage — ±5 V.

Input Signal Range — 2 V p-p maximum within a +2 V to −2 V window at any sensitivity.

Dc Offset Range — At least +2 V to −2 V.

TIME BASE

Scan Modes — Repetitive, Single, Manual, or External.

Horizontal Signal Output — 1.0 V/div of horizontal deflection; 10 kΩ source resistance.

DELAYING SWEEP

Range — 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).

Delay Accuracy — Within ±1% of 10 div when measurement is made within the last 9.5 div.

DELAYED SWEEP

Range — 100 ps/div to 100 μs/div in 19 calibrated steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Delay Jitter — <0.05% of the time represented by 1 div of the Delaying Sweep selected.

TRIGGERING AND SYNC

Signal Source — Interval from CH 1 vertical input or external through front-panel connector.

External Triggering — Nominal 50 Ω input, ac coupled, 2 V p-p, 50 V dc maximum. Trigger pulse amplitude 10 mV p-p or more with risetime of 1 μs or less. 10 Hz to 100 MHz. Sinewave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

Internal Triggering — Pulse amplitude 50 mV p-p or more with risetime of 1 μs or less. Sinewave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

Order 5S14N Sampler **$5,630**

PORTABLE OSCILLOSCOPES

CONTENTS

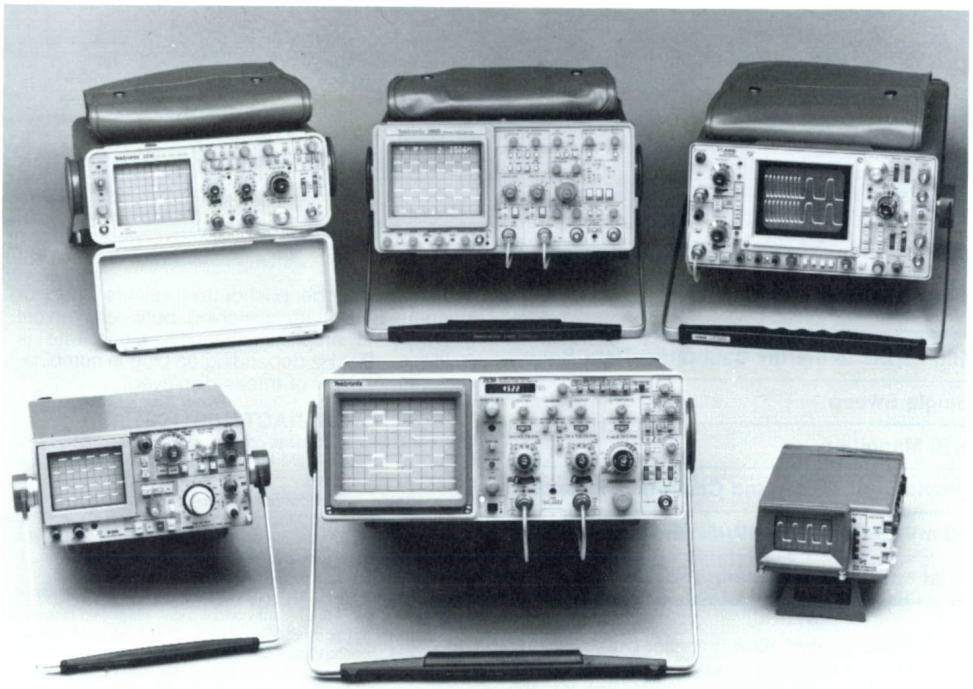
Portable Scopes Comparison Chart 299
Portable Scopes Application Notes 300
Portable Scopes Accessories Chart 300

Portable Nonstorage Oscilloscopes

485 350 MHz Dual Trace 301
2465 300 MHz Four Trace 303
2445 150 MHz Four Trace 303
2335 100 MHz Dual Trace 307
2336 100 MHz Dual Trace w/Δ Time 307
2337 100 MHz Dual Trace w/Δ Time & DMM 307
2235 100 MHz Dual Trace, Dual Time Base 309
2236 100 MHz Dual Trace, Dual Time Base, w/Counter, Timer, Multimeter 309
2213 60 MHz Dual Trace 311
2215 60 MHz Dual Trace, Alternate Time Base 311
465M AN/USM-425 (V)1 100 MHz Dual Trace Tri-Service Standard ... 313
335 35 MHz Dual Trace 315
305 Battery Powered 5 MHz/DMM 316
221 5 MHz 317
213 1 MHz/DMM 318
212 500 kHz Dual Trace 319
T922R 15 MHz Dual Trace Rackmount 320

Portable Storage Oscilloscopes

466/464 100 MHz Dual Trace 321
434 25 MHz Dual Trace 323
314 10 MHz Dual Trace 324
214 500 kHz Dual Trace 325
T912 10 MHz Dual Trace 326
468 100 MHz Dual Trace Digital Storage 350
336 50 MHz Digital Storage 352



PORTABLE REAL TIME OSCILLOSCOPES COMPARISON CHART

PRODUCT	BANDWIDTH (MHz)	SENSITIVITY (mV/div)	TRACE	DELAYED SWEEP	FASTEST SWEEP (ns/div)	FEATURES	SIZE mm (in) HxWxD	WEIGHT kg (lb)	POWER REQUIREMENTS	PAGE
485	350*1	5	Dual	yes	1	Widest BW in a portable instrument	170x310x470 (7x12x19)	9.5 (21)	Line (90-136/180-272 V ac, 48-440 Hz)	301
2465	300	2	4	Yes	500 ps	CRT Readout, ΔVolts ΔTime Cursors	190x330x434 (7.5x13x17.1)	10.2 (22.4)	Line (90-132/180-250 V ac, 48-440 Hz)	303
2445	150	2	4	Yes	1	CRT Readout, ΔVolts ΔTime Cursors	190x330x434 (7.5x13x17.1)	10.2 (22.4)	Line (90-132/180-250 V ac, 48-440 Hz)	303
465M	100	5	Dual	yes	5	Tri-service standard 100 MHz portable	180x320x550 (7x13x24)	10.9 (24)	Line (100-132/200-264 V ac, 48-440 Hz)	313
2335	100	5	Dual	yes	5	Rugged, compact lightweight	140x270x430 (5x11x17)	7.7 (17)	Line (100-132/200-250 V ac, 48-440 Hz)	307
2336	100	5	Dual	yes	5	B trigger, Δtime	140x270x430 (5x11x17)	7.7 (17)	Line (100-132/200-250 V ac, 48-440 Hz)	307
2337	100	5	Dual	yes	5	B trigger, Δtime, DMM	140x270x430 (5x11x17)	7.7 (17)	Line (100-132/100-250 V ac, 48-440 Hz)	307
2235	100	2	Dual	Yes	5	Dual Trace, Dual Time Base	140x240x440 (5x14x17)	13.5	Line (90-250 V ac, 48-440 Hz)	309
2236	100	2	Dual	Yes	5	Dual Trace, Dual Time Base with Counter, Timer, Multimeter	140x240x440 (5x14x17)	13.5	Line (90-250 V ac, 48-440 Hz)	309
2213	60*2	2	Dual	yes	5	Low cost delayed sweep	140x240x440 (5x14x17)	6.1 (13.5)	Line (90-250 V ac, 48-440 Hz)	311
2215	60*2	2	Dual	yes	5	Dual time base delayed sweep	140x240x440 (5x14x17)	6.1 (13.5)	Line (90-250 V ac, 48-440 Hz)	311
335	35	10	Dual	yes	20	1 mV sensitivity at 25 MHz, external dc power	110x240x350 (4.4x9x14)	4.7 (10.3)	Line (90-132/180-264 V ac, 48-440 Hz) or external dc	315
T922R	15	2	Dual	no	20	Rackmount, front and rear inputs	130x480x430 (5.25x19x17)	9.1 (20)	Line (90-132/198-250 V ac, 50-60 Hz)	320
305	5	5	Dual	no	100	Autoranging DMM battery power	110x240x370 (4.4x9x15)	4.8 (10.6)	Line (90-132/180-264 V ac, 48-440 Hz) built-in battery, or external dc	316
221	5	5	no	no	100	5 MHz hand-held	80x130x230 (3x5x9)	1.6 (3.5)	Built-in battery,line (90-250 V ac, 48-62 Hz)	317
213	1	20	no	no	400	DMM/scope at <4 lbs	70x130x230 (3x5x9)	1.7 (3.7)	Built-in battery, line (90-136/ 180-250 V ac, 48-62 Hz), or external dc	318
212	0.5 (500 kHz)	10	Dual	no	1000 (1 μs/div)	Integral 1 MΩ probe	80x130x240 (3x5x10)	1.6 (3.5)	Built-in, battery, line (104-126 V ac 58-62 Hz)	319

PORTABLE STORAGE OSCILLOSCOPES COMPARISON CHART

468	100	5	Dual	yes	2	GPIB Interface option 10 MHz Stored Writing Speed*3	160x330x550 (6x13x22)	12.7 (28)	Line (90-132/198-250 V ac 48-440 Hz)	350
466	100	5	Dual	yes	5	Two storage modes and reduced scan 3000 div/μs Stored Writing Speed	160x330x550 (6x13x22)	11.8 (26)	Line (99-132/198-264 V ac, 48-440 Hz) or battery pack	321
464	100	5	Dual	yes	5	Two storage modes 110 div/μs Stored Writing Speed	160x330x550 (6x13x22)	11.8 (26)	Line (99-132/198-264 V ac 48-440 Hz) or battery pack	321
336	50	5	Dual	yes	100	Digital Storage 1 Ms/s Microprocessor control and Menu driven*3	112x237x482 (4.4x9.3x14.6)	11.3	Line (90-132/180-250 V ac 48-440 Hz)	352
434	25	10	Dual	no	20	Split screen storage 5000 div/μs Stored Writing Speed	140x330x480 (6x13x19)	9.4 (20.7)	Line (99-136/180-272 V ac, 48-440 Hz) or external dc	323
314	10	1	Dual	no	100	Stored Viewing Time to 4 hr 400 div/ms Stored Writing Speed	110x240x350 (4.4x9x14)	4.7 (10.3)	Line (90-132/180/264 V ac, 48-440 Hz) or external dc	324
T912	10	2	Dual	no	50	Low cost bistable storage 250 div/ms Stored Writing Speed	250x180x480 (10x7x19)	8.2 (18)	Line (90-132/198-250 V ac 50-60 Hz)	326
214	0.5 (500 kHz)	10	Dual	no	1000 (1 μs/div)	Fully self-contained 500 div/ms Stored Writing Speed	80x130x240 (3x5x10)	1.6 (3.5)	Built-in battery or line (104-126 V ac, 58-62 Hz)	325

*1 *Bandwidth specifications for the 485 are dc to 350 MHz with 50 Ω inputs and dc to 250 MHz with 1 MΩ inputs.*
*2 *The 2213 and 2215 are specified at 60 MHz for sensitivities from 10 V/div (10X probe) to 20 mV/div (1X probe) and 50 MHz from 10 mV/div to 2 mV/div.*
*3 *See specifications in digitizer section.*

PORTABLE SCOPE APPLICATION NOTES

Tektronix product literature is readily available from your local Tektronix Sales office. Addresses and phone numbers are listed on pages 10 through 12 of this catalog. For data sheets and product brochures, just ask for literature on the specific instrument. Additional related publications also available are listed below.

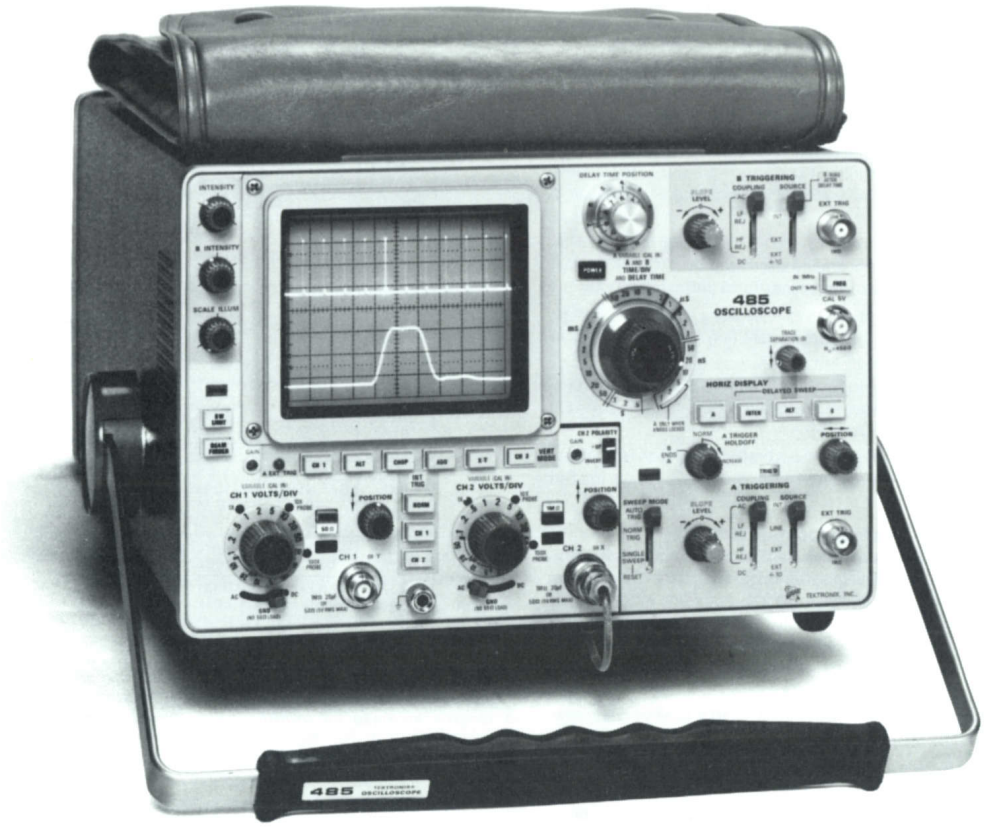
TITLE	FEATURING	PART NO
Portable Oscilloscope Selection Guide	A helpful aid for choosing the right portable scope for your needs	38W-5158
Miniature, Battery-Powered Scopes	Built to Tek's High-Performance Standards	40A-5000
300 Series Portable Oscilloscopes	Brochure for the full line of SONY-TEKTRONIX mini-portable scopes	40AX-3792-2
400 Series Portable CRT Storage Scopes	Descriptions of the 466, 464, and 434 portable storage scopes	40A-3793-2
T900 Series Data Sheet	Includes the popular T922R rackmount scope and the T912 low cost storage scope. Ask for 2200 Series literature to supplement this data sheet	41X-3933-3
XYZs Of Using a Scope	A basic primer that features the 2213	41AX-4758
Basic Oscilloscope Measurements:	Period and Frequency	41AX-3839-1
Basic Oscilloscope Measurements:	Amplitude	41AX-3840-1
Basic Oscilloscope Measurements:	Setup and Analysis	41AX-3841-1
Basic Oscilloscope Measurements:	Dual-Trace and X-Y Phase	41AX-3928
Basic Oscilloscope Measurements:	Risetime	41AX-3929
Using Delayed Sweep In Measuring Digital Word Trains		41AX-3349
VITS Analysis for TV Servicing		41AX-4047-1
Troubleshooting Color TV Power Supplies		41AX-4048-1
The Digital Storage Oscilloscope	A primer that describes digital storage concepts and the 468	40AX-4319-2
Variable Persistence Storage Applications		42AX-3198
Bistable Storage Applications		42AX-3199
Spotlight Hidden Pulses With High Speed Storage	Three-page application note that features the 466	40AX-3225
468 *BROADCAST ENGINEERING* Reprint	Making broadcast timing measurements with the 468	40AX-4483
External Storage For The 468 Digital Storage Oscilloscope	Application note describes transferring waveforms captured with the 468 to external data storage devices	40AX-4614
Using The 468 in Envelope Mode	Application note on the 468 envelope mode for glitch-catching and babysitting applications	40AX-4615
468 *COMPUTER DESIGN* Reprint	Dual sampling rates in the 468 envelope mode	40AX-4838
Your Direct Line to the World's Best Instruments and Technical Expertise	Find out about the Tektronix National Marketing Center and Tek's service offices	60A-4873-1
2400 Series Oscilloscopes	Brochure describing the 2445 and 2465 scopes	38W-5139
Dual Delay Sweep Measurements		38W-5220
2000 Series Warranty Brochure	Describes Tek's 3 year warranty on 2000 Series scopes and 5 year warranty plus service	81W-5258

PORTABLE SCOPE ACCESSORIES CHART

	PROBES			CAMERAS			CART	MISCELLANEOUS ACCESSORIES
400 SERIES	**Passive**	**Active**	**Current**	**Single Shot or Low Rep Rate**	**Stored/Stable or Repetition**	**Low Cost**		
485	P6101 P6063B P6106 P6015 P6056 P6009 P6057 P6048 P6122 P6130	P6201 P6202A P6230	P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B 016-0306-01 adaptor*1	C-30B 016-0306-01 adaptor*1	NA	200D 200C	Folding Viewing Hood 016-0274-00 & 016-0082-00; 1105 Battery Power Supply Rain Cover 016-0554-00; Rack Adaptor 016-0558-00.
468	P6101 P6015 P6105 P6009 P6062B P6048 P6122 P6130	P6201 P6202A P6230	P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B Opt 01 016-0269-03 adaptor*1	C-30B Opt 01 016-0269-03 adaptor*1	C-5C Opt 02 016-0359-01 adaptor*1	200D 200C	Viewing Hood (Binocular) 016-0566-00; Folding Polarized Viewing Hood 016-0180-00; 1105 or 1106 Battery Power Supply Mesh Filter 378-0726-01; Rack Adaptor (468) 016-0675-00.
465M	P6101 P6015 P6104 P6009 P6122 P6130	P6201 P6202A	P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B Opt 01 016-0269-03 adaptor*1	C-30B Opt 01 016-0269-03 adaptor*1	C-5C Opt 02 016-0359-01 adaptor*1	200D 200C	Folding Polarized Viewing Hood 016-0180-00; Mesh Filter 378-0726-01; 1105 Battery Power Supply; Rack Adaptor 040-0825-01.
466 464	P6101 P6015 P6105 P6009 P6062B P6130 P6122	P6201 P6202A	P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B Opt 01 016-0269-03 adaptor*1	C-30B Opt 01 016-0269-03 adaptor*1	C-5C Opt 02 016-0359-01 adaptor*1	200D 200C	Folding Polarized Viewing Hood 016-0180-00; Collapsible Viewing Hood (Binocular) 016-0566-00; Protective Cover 016-0365-00; Mesh Filter 378-0726-01; 1105 Battery Power Supply; Rack Adaptor 016-0675-00.
434	P6101 P6015 P6108 P6122 P6009		P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B Opt 01 016-0269-03 adaptor*1	C-30B Opt 01 016-0269-03 adaptor*1	C-5C Opt 02 016-0359-01 adaptor*1 (handheld)	200D 200C	Folding Polarized Viewing Hood 016-0180-00; Mesh Filter 378-0682-00; 1105 Battery Power Supply; Rack Adaptor 016-0272-00.
2400 SERIES								
2445 2465	P6101 P6015 P6131 P6009 P6048	P6201 P6202A P6230	P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B Opt 01 016-0269-03 adaptor*1	C-30B Opt 01 016-0269-03 adaptor*1	C-5C Opt 02 016-0359-01 adaptor*1	200D 200C	Folding Polarized Viewing Hood 016-0180-00; Collapsible Viewing Hood (Binocular) 016-0566-00; 1105 Battery Power Supply; Protective Cover 016-0720-00.
2300 SERIES								
2335 2336 2337	P6063B P6130	P6202A	P6021 P6022 A6302/AM 503 A6303/AM 503	NA	NA	C-5C Opt 04 016-0359-01 adaptor*1 (with flash)	NA	2335 Rack Adaptor Kit 016-0468-00.
2200 SERIES								
2213, 2215 2235 2236	P6101 P6122 P6121 (2236)		P6021 P6022 A6302/AM 503 A6303/AM 503			C-5C Opt 04 016-0359-01 adaptor*1 (with flash)	200D 200C	Clear CRT Light Filter Custom Mod 337-2775-01; CRT TV Graticule Custom Mod 035-0175-00; Accessories Pouch 016-0677-00; Front Cover 200-2520-00; RM Kit: 016-0466-00 for 2213, 2215 and 2235; 016-0015-00 for 2236; P6602 Temperature Probe 010-6602-00.
300 SERIES								
314 305 335 336	P6101 P6149A		P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B 016-0327-01 adaptor	C-30B 016-0327-01 adaptor		NA	Viewing Hood 016-0297-00; Mesh Filter 378-0063-00; 1105 Battery Power Supply; Rain Cover (314, 335) 016-0612-00.
T900 SERIES								
T912	P6101 P6015 P6108 P6122 P6062B P6007		P6021 P6022 A6302/AM 503 A6303/AM 503			C-5C Opt 03 016-0358-01 adaptor*1 (with flash)	NA	Protective Cover 016-0340-00; Dust/Rain Jacket 016-0361-00.
T922R	P6101 P6015 P6108 P6122 P6062B P6007		P6021 P6022 A6302/AM 503 A6303/AM 503			C-5C Opt 01 016-0357-01 adaptor*1	NA	Viewing Hood 016-0377-00.

**1 Mounting adaptor comes with camera/option listed, others are optional.*

350 MHz DUAL TRACE OSCILLOSCOPE



485

350 MHz at 5 mV/div

1 ns/div Sweep Rate

2.0 div/ns Writing Speed

1 MΩ and 50 Ω Input Impedances

Input Protection 50 Ω Internal

Automatic Deflection Factor Readout

Pushbutton Ext Trigger View

Battery Operation (Optional)

Weighs ≈9.5 kg (21 lb)

At just 21 pounds, the 1 ns/div dual-trace 485 is the only true portable, 350 MHz oscilloscope on the market. This wide bandwidth is one reason why the 485 is highly compatible with today's increasing technology.

Many features contribute to the 485's extraordinary overall performance. Fast 2.0 div/ns writing speed is one, making it especially attractive for use in field research environments.

The 485 features a wide bandwidth at its full 5 mV/div vertical sensitivity (350 MHz at 50 Ω and 250 MHz at 1 MΩ). Selectable input impedance provides the capability to measure low and high impedance points with the same scope and without active probes.

Internal detection circuitry protects the 50 Ω input by automatically disconnecting when the signal exceeds approximately 5 V RMS.

You no longer have to mentally compensate for attenuating probes. Automatic vertical scale-factor readout is provided by three light-emitting diodes located around the edge of each input attenuator knob. A quick glance at the readout tells the operator the correct on-screen V/div when the recommended 10X or 100X probes are used.

You always know exactly where you are in a pulse train when making a delayed sweep measurement. An alternate sweep mode allows the delayed sweep to appear alternately with the intensified main sweep. In this mode, you can view the intensified zone and the delayed display simultaneously.

The external trigger signal can be easily viewed on the 485. A front-panel pushbutton automatically routes the external signal used to trigger time base A to the vertical deflection amplifier. This feature can also be used to quickly make time comparisons between the signal of interest and the external trigger signal.

On the 485, focus is always correct for single-shot photography. An autofocus circuit eliminates the need to readjust the focus each time the intensity is changed.

When commercial power is not available, use the 1105 Battery Power Supply. It weighs only 19.5 pounds, and lets you take the high-performance 485 virtually anywhere.

Often chosen as a general-purpose scope for computer and electronic servicing environments because of its fast writing speed and wide bandwidth, the 485 can also be found in specialized and unusual applications. For example, to maintain a groundbased laser/radar acquisition system, the 485's alternate sweep switching capability can be very useful.

CHARACTERISTICS

VERTICAL DEFLECTION

(2 IDENTICAL CHANNELS)

Bandwidth*1 and Risetime*2

	−15°C to +35°C	+35°C to +55°C
50 Ω	Dc to 350 MHz, 1 ns	Dc to 300 MHz, 1.2 ns
1 MΩ	Dc to 250 MHz, 1.41ns	Dc to 200 MHz, 1.8 ns

*1 *Measured at −3 dB. Bandwidth may be limited to ≈20 MHz by bandwidth limit switch.*

*2 *At all deflection factors from 50 Ω terminated source.*

Lower −3 dB Point, Ac Coupling — 1X Probe: 1 kHz or less for 50 Ω, and 10 Hz or less for 1 MΩ. 10X Probe: 100 Hz or less for 50 Ω, and 1 Hz or less for 1 MΩ.

Deflection Factor — Calibrated: 5 mV/div to 5 V/div (1-2-5 sequence). Accuracy: +2%. Uncalibrated: Continuously variable between steps and to at least 12.5 V/div. Gain can be recalibrated at the front panel.

Display Modes — CH 1, CH 2 (normal and inverted), Alternate, Chopped (≈1 MHz rate), X-Y (CH 1-Y and CH 2-X), Add (CH 1 ± CH 2).

Common-Mode Rejection Ratio — At least 20 dB at 50 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X, 10X, and 100X coded probes are automatically indicated by three readout lights at the edge of the knob skirts. All lights are off when the channel is not selected for display or when the trace identification control on the probe is depressed.

Selectable Input Impedance — 50 Ω and 1 MΩ impedances are available at a single BNC connector by pushbutton selection. 50 Ω ±0.5%; VSWR 1.15:1 or less from 20 mV/div to 5 V/div, 1.25:1 or less at 5 mV/div and 10 mV/div to 350 MHz.

Input R and C — 1 MΩ ±1% paralleled by ≈20 pF.

50 Ω Protection — Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated, and has manual reset.

Maximum Input Voltage

50 Ω	Protection disconnect occurs for voltages that exceed approximately: 5 V RMS continuous 0.1 W-second for instantaneous voltages of 5 V to 50 V	
	Signals in excess of 150 V will damage the instrument	
1 MΩ	Dc coupled	250 V (dc + peak ac), 500 V p-p to 1 kHz
	Ac coupled	500 V (dc + peak ac) 500 V p-p to 1 kHz

Selectable Input Coupling — Ac; dc; GND (provides zero reference, precharges coupling capacitor, disconnects 50 Ω load in 50 Ω mode).

Delay Line — Permits viewing leading edge of displayed waveform.

Probe Power — Connectors provide correct voltages for two optional P6201, P6202A or P6230 active probes.

HORIZONTAL DEFLECTION

Time Base A and B — Calibrated Sweep Range: 1 ns/div to 0.5 s/div (1-2-5 sequence).

Variable Time Control — Time Base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div.

Time Base A and B Accuracy*1

Sweep Rate	+15°C to +35°C	−15°C to +55°C
1 ns/div to 20 ns/div	±3%	±5%
50 ns/div to 0.1 s/div	±2%	±4%
0.2 s/div and 0.5 s/div	±3%	±5%

*1 *Center 8 division.*

Horizontal Display Modes — A, Intensified, Alternate, and B (delayed sweep). A only is displayed for A sweep rates of 1, 2, and 5 ns/div. B ends A for increased intensity in the delayed mode.

Alternate Display Modes — Allows the B delayed sweep to appear alternately with the intensified A sweep. Trace separation control positions B (delayed sweep ≈4 div from the A sweep).

CALIBRATED SWEEP DELAY

Delay Time Range — 0 to 10X delay time/div setting of 10 ns/div to 0.5 s/div.

Differential Delay Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C
10 ns/div and 20 ns/div	±(1% of measurement +0.2% of full scale)*1
50 ns/div to 1 ms/div	±(0.5% of measurement +0.1% of full scale)*1
2 ms/div to 0.5 s/div	±(1% of measurement +0.1% of full scale)*1

*1 *Full scale is 10 times the delay time/div setting.*

Jitter — 1 part or less in 20,000 of 10X the time/div setting.

TRIGGERING A and B

A Trigger Modes — Normal (sweep runs when triggered). Automatic (sweep free-runs in the absence of a triggering signal and for signals below 20 Hz). Single sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights Indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive complex waveforms. The control covers at least the time of one full sweep for faster than 0.2 s/div.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity and Coupling

Coupling	To 50 MHz	To 350 MHz
Dc Internal	0.3 div deflection	1.5 div deflection
Dc External	20 mV	100 mV
Ac	Signals below 16 Hz are attenuated	
Ac LF Reject	Signals below 16 kHz are attenuated	
Ac HF Reject	Signals below 16 Hz and above 50 kHz are attenuated	

Jitter — 0.1 ns or less at 350 MHz at 1 ns/div.

A Trigger View — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the external signal and time comparison between a vertical signal and the external trigger signal. The deflection factor is ≈50 mV/div (0.5 V/div with external ÷ 10 source).

Level and Slope — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. External, level is adjustable through at least ±0.5 V for either polarity; ±5 V for external ÷ 10.

A Sources — Internal, line, external, external ÷ 10.

B Sources — B runs after delay time, internal, external, external ÷ 10.

External Inputs — R and C ≈1 MΩ paralleled by ≈20 pF. Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p to 1 kHz.

X-Y OPERATION

Full Sensitivity X-Y (CH 1 Vertical, CH 2 Horizontal) — 5 mV/div to 5 V/div, accurate ±2%. Y-axis bandwidth identical to CH 1. X-axis bandwidth is dc to at least 4 MHz (−3 dB). Phase difference between amplifiers is 3° or less to 4 MHz.

DISPLAY

CRT — 8 x 10 division display, each division is 0.8 cm. Horizontal and vertical centerlines further marked in 0.2 division increments. GH (P31) Phosphor is standard; BE (P11) optional. 21 kV accelerating potential.

Photographic Writing Speed — At least 1 div/ns with standard GH (P31) Phosphor and at least 2 div/ns with optional BE (P11) Phosphor using the Tektronix C-31B Camera and 3000 speed Type 107 film.

Auto Focus — Automatically maintains beam focus for all intensity settings.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an off-screen signal.

Z-Axis Input — Risetime ≈15 ns. Input R ≈500 Ω. +0.2 V (dc to 20 MHz) decreases intensity. +2 V (dc to 2 MHz) blanks maximum intensity trace.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −35°C to +75°C. Filtered forced air ventilation is provided.

Altitude — Operating: To 4600 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the 3 axes. 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

Humidity — Operating and Nonoperating: 5 cycles (120 hrs) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, Class 4).

Shock — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Two-Frequency, Fast-Rise Calibrator — Output resistance is 450 Ω with a risetime (positive slope) into 50 Ω of 1 ns or less. 1 kHz, duty cycle 49.8% to 50.2%, Amplitude is 5 V ±0.5% into 1 MΩ and 0.5 V ±1% into 50 Ω (±0.5%). Optional BNC accessory current loop provides 50 mA ±1%. Selectable repetition rates are 1 kHz and 1 MHz ±0.25%. Specifications apply over +15°C to +35°C range.

A Sweep Output — Open Circuit: ≈10 V positive-going sawtooth; into 50 Ω, ≈0.5 V.

A and B Gate Outputs — Open Circuit: ≈4 V positive-going rectangular pulse; into 50 Ω ≈0.5 V.

Power Requirements — Recessed slide switch selects nominal operating line range. Line Voltage Range: 90 V to 136 V and 180 V to 272 V. 60 W maximum power consumption at 115 V. Line Frequency: 48 Hz to 440 Hz.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	305	12.0	483	19.0
Height	168	6.6	177	7.0
Depth			457	18.0
(handle extended)	523	20.6		
(handle not extended	470	18.5		
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net (with accessories)	10.9	24.0		
Net (without accessories)	9.5	21.0	11.9	26.2
Shipping	15.0	33.0	24.5	54.0

INCLUDED ACCESSORIES

18 inch 50 Ω BNC cable (012-0076-00); two BNC jack posts (012-0092-00); two 50 Ω terminators (011-0049-01); clear filter (386-0118-00); four 3 amp fuses (159-0015-00); accessory pouch (016-0535-00) or (016-0537-00);. Rack models also include mounting hardware and slide out assemblies. Service manual, operators manual.

ORDERING INFORMATION

485 Oscilloscope **$8,320**

R485 Rackmount Oscilloscope **$8,595**

Option 04 — EMC Modification for 485/R485 ..... **+$180**

Option 78 — BE (P11) Phosphor ..... **+$150**

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 224 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

For more information on instrument options, see your Tektronix Sales Engineer, Distributor, or Representative.

OPTIONAL ACCESSORIES

Probes

Input Terminal	Probe Type	Attenuation	Input Impedance	Bandwidth*1 with 485
50 Ω Input	P6056 6 ft	10X	500 Ω 1 pF	350 MHz
	P6057 6 ft	100X	5000 Ω 1 pF	350 MHz
	P6201 FET 2 m	1X 10X Head 100X Head	100 kΩ 3 pF 1 MΩ 1.5 pF 1 MΩ 1.5 pF	330 MHz
50 Ω or 1 MΩ Input	P6230 1.5 m	10X	450 Ω 1.3 pF	350 MHz
	P6202A 2 m	10X 100X Head (optional)	10 MΩ 2 pF	285 MHz
1 MΩ Input	P6106 2 m	10X	10 MΩ 13 pF	250 MHz
	P6130 1.5 m	10X	10 MΩ 12.7 pF	250 MHz
	P6063B 6 ft	1X Switchable 10X	1 MΩ 12 pF 10 MΩ 14 pF	6 MHz 200 MHz
Current Probe	**Probe Type**	**Calibration**	**Insertion Impedance**	**Bandwidth*1 with 485**
1 MΩ Input	P6022 5 ft	1 mA/mV 10 mA/mV (selectable)	0.03 Ω @ 1 MHz Increasing to 0.2 Ω @ 120 MHz	130 MHz

*1 *Bandwidths are measured at the upper −3 dB, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.*

Carrying Strap — Order 346-0199-00 ..... **$15**

Current Loop Adaptor — The adaptor provides an accurate 50 mA squarewave calibrator when connected to the 485 voltage calibrator. The risetime is ≈25 ns.
Order 012-0341-00 ..... **$45**

50 Ω 5X Pad — Provides reverse termination for the calibrator.
Order 011-0060-02 ..... **$35**

Folding Viewing Hoods
Folds to 1.2 x 11.5 x 19.1 cm (7/16 x 7 1/2 x 7 1/2 in).
Order 016-0274-00 ..... **$15**

Folds to 1.4 x 17.2 x 34.9 cm (9/16 x 6 3/4 x 13 3/4 in).
Order 016-0082-00 ..... **$15**

SCOPE-MOBILE® Cart — Occupies <18 in aisle space, has storage area in base. Order 200D or 200C **$320**

Battery Power Supply
Order 1105 Battery Power Supply **$1,430**

Rack Adaptor — Order 016-0558-00 ..... **$320**

RECOMMENDED CAMERAS

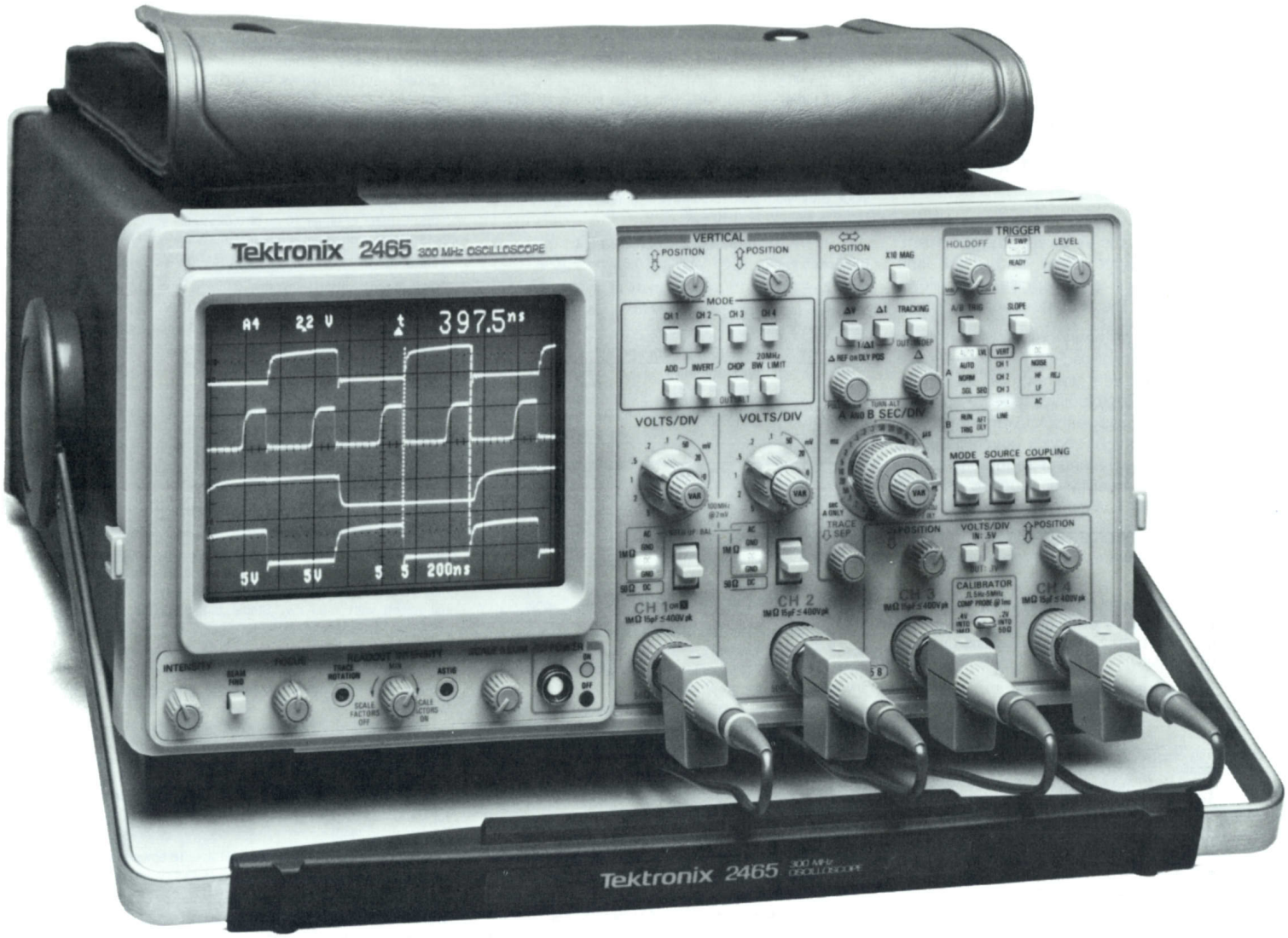
C-30BP General Purpose Camera — Includes 016-0306-01 mounting adaptor. Order C-30BP **$1,375**

C-31BP High Speed Camera — Includes 016-0306-01 mounting adaptor. Order C-31BP **$1,585**

For further information see camera section.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

NEW



2465/2445

- 300 MHz Bandwidth at the Probe Tip (2465)
- 150 MHz Bandwidth at the Probe Tip (2445)
- 500 ps/div Sweep Rate (2465)
- 1 ns/div Sweep Rate (2445)
- Time Interval Resolution to 20 ps
- Four Independent Channels
- 2 mV/div Vertical Sensitivity
- ΔVolts, ΔTime Cursors
- CRT Readout
  - Scale Factors
  - Trigger Level
  - Voltage, Time, Frequency, Phase and Ratio Measurements
  - Mode Indicators
- Adjustable Channel 1/Channel 2 Delay Matching
- Advanced Triggering System Featuring the "Hands Off" Auto Level Trigger
- Minimum Triggering Bandwidth of 500 MHz (2465) and 250 MHz (2445)
- B Sweep Displays the A Sweep Trigger Event
- 50 Ω/1 MΩ Inputs with 50 Ω Protection
- Calibrated Horizontal Variable
- Three Channel X-Y Display
- Rugged Design
- Three Year Warranty—Five Year Option

The new 300 MHz 2465 and 150 MHz 2445 represent the state-of-the-art and a higher standard in value for today's portable oscilloscopes. They make better measurements faster than any previous portable oscilloscopes. Cursors avoid interpretation errors and increase operator productivity. Four channels give complete views to simplify complex measurements. The front panel Channel 1/Channel 2 delay matching adjustment eliminates the effects of probe and vertical channel delay differences.

The 2465/2445 provide 1% horizontal accuracy and 2% vertical accuracy for greater measurement confidence. On-screen vertical and horizontal cursors deliver immediate measurements of voltage, time, frequency, ratio and phase with CRT readout. CRT readouts also include: scale factors for easy setup and interpretation of waveforms, including a calibrated horizontal variable; trigger level readout for predictable triggering on logic signals and transient events; and mode indicators, such as add, invert, bandwidth limit, and more.

NEW

2400 Series scopes can trigger on any or all of the four channels. The new Auto Level mode provides "hands off" triggering on any pulse width or waveform at repetition rates down to 50 Hz. Single Sequence Trigger mode sequentially sweeps through each channel displayed when triggered, then flashes the CRT readouts and graticule illumination.

The B sweep can display any portion of the A sweep, including the A sweep trigger event. This provides accurate delay and delta time measurements from the "first pulse" and allows the user to examine the A trigger event in detail.

In strong testimony of the incomparable reliability of the 2000 Family oscilloscopes, Tek offers the industry's first three year warranty: All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

CHARACTERISTICS

Characteristics are common to the 2445/2465 except where indicated.

VERTICAL DEFLECTION SYSTEM

Vertical Display Modes — CH 1, CH 2, CH 3, CH 4, Add (CH 1 + CH 2); Invert (CH 2 only); Alternate and Chopped. Bandwidth Limit (20 MHz).

CHANNEL 1 AND CHANNEL 2

Deflection Factor Range — 2 mV/div to 5 V/div in a 1-2-5 sequence.

Accuracy — +15°C to +35°C: Within 2% for ≤5 div signals, centered vertically. −15°C to +15°C and +35°C to +55°C: Add 1% to +15°C to +35°C range.

ΔV Accuracy (Using Cursors Over the Entire Graticule Area) — +15°C to +35°C: ±1.25% of reading +0.03 div. −15°C to +15°C and +35°C to +55°C: Add 1% of reading to +15°C to +35°C range.

ΔV Range — ±8 times Volts/Div setting.

Variable Range — Continuously variable between Volts/Div switch settings. Extends 5 V/div deflection factor to at least 12.5 V/div.

Frequency Response (3 dB Bandwidth and Risetime*[1]) — With a 6 div signal, terminated 50 Ω, with Var Volts/Div in calibrated detent.

2465	Volts/Div Setting	With Standard Accessory Probe or Internal 50 Ω Termination
−15°C to +35°C	5 mV or greater	Dc to 300 MHz, 1.17 ns
+35°C to +55°C	5 mV or greater	Dc to 250 MHz, 1.4 ns
−15°C to +55°C	2 mV	Dc to 100 MHz, 3.5 ns
2445		
−15°C to +35°C	5 mV or greater	Dc to 150 MHz, 2.33 ns
+35°C to +55°C	5 mV or greater	Dc to 100 MHz, 3.5 ns
−15°C to +55°C	2 mV	Dc to 80 MHz, 4.5 ns

[1] Risetime calculated from: Bandwidth x Risetime = 0.35

Ac Coupled Lower −3 dB Point — With 1X Probe: 10 Hz or less. With 10X Probe: 1 Hz or less.

Common-Mode Rejection Ratio — At least 20:1 at 50 MHz for common-mode signals of 8 div or less, with Var Volts/Div control adjusted for best CMRR at 50 kHz at any Volts/Div setting ≥5 mV. At least 20:1 at 20 MHz at 2 mV/div.

Channel Isolation — For an 8 div Input Signal from 2 mV/div to 500 mV/div, with Equal Volts/Div Settings on Both Channels: 100:1 or greater attenuation of the deselected channel at 100 MHz; 50:1 or greater attenuation at 300 MHz (150 MHz for 2445).

CH 1 to CH 2 Signal Delay — The displayed delay is adjustable through a range of at least ±500 ps.

Input Z (1 MΩ) — 1 MΩ ±0.5% shunted by 15 pF, ±2 pF. The maximum input voltage is 400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less.

Input Z (50 Ω) — 50 Ω ±1%, with a vswr from dc to 300 MHz of 1.3 to 1 or less. The maximum input voltage is 5 V RMS, or 0.5 W/s during any 1 s interval for instantaneous voltages from 5 V to 50 V.

Cascaded Operation — CH 2 Signal Out is coupled into CH 1 input. Bandwidth is dc to 50 MHz or greater and the deflection factor is 400 μV/div ±10%.

CHANNEL 3 AND CHANNEL 4

Deflection Factor — 0.1 V/div and 0.5 V/div ±10%.

Input Z — 1 MΩ ±1%, shunted by 15 pF ±3 pF.

Maximum Input Voltage — 400 V (dc + peak ac): 800 V p-p ac at 10 kHz or less.

Frequency Response (Bandwidth and Risetime)*[1]

2465	With Standard Accessory Probe (−3 dB)	With 50 Ω External Termination
−15°C to +35°C	Dc to 300 MHz 1.17 ns	Dc to 300 MHz, (−4.7 dB) 1.4 ns
2465		
+35°C to +55°C	Dc to 250 MHz 1.4 ns	Dc to 250 MHz, (−4.7 dB) 1.75 ns
2445		
−15°C to +55°C	Dc to 150 MHz 2.33 ns	Dc to 150 MHz, (−3 dB) 2.33 ns

[1] With a 6 div signal, from a 50 Ω terminated source.

Channel Isolation — 50:1 or greater attenuation of the deselected channel at 100 MHz with an 8 div input signal.

ALL CHANNELS

Low Frequency Linearity — 0.1 div or less compression or expansion of a 2 div, center-screen signal when positioned anywhere within the graticule area.

Bandwidth Limiter — Reduces upper 3 dB bandpass to a limit of 13 MHz to 24 MHz.

Vertical Signal Delay — At least 30 ns of the signal is displayed before the triggering event is displayed on the A sweep for settings ≥10 ns/div. At least 10 ns of delay is displayed at 5 ns/div for the 2465.

Chopped Mode Switching Rate — 2.5 MHz ±0.2% from 2 μs/div to 20 μs/div (1.25 MHz dual channel cycle rate). At All Other Sweep Speeds: 1 MHz ±0.2% (500 kHz dual channel cycle rate).

HORIZONTAL DEFLECTION SYSTEM

Horizontal Display Modes — A, A Intensified, B Delayed, Alternate (A Intensified and B Delayed), B ends A for increased intensity in the delayed mode. For X-Y operation Channel 1 supplies the X-axis (horizontal) deflection.

A Sweep Time Base Range

2465: 0.5 s/div to 5 ns/div in a 1-2-5 sequence of 25 steps. X10 Mag feature extends maximum sweep speed to 500 ps/div.

2445: 1 s/div to 10 ns/div in a 1-2-5 sequence of 25 steps. X10 Mag feature extends maximum sweep speed to 1 ns/div.

B Sweep Time Base Range

2465: 50 ms/div to 5 ns/div in a 1-2-5 sequence of 22 steps. X10 Mag feature extends maximum sweep speed to 500 ps/div.

2445: 50 ms/div to 10 ns/div in a 1-2-5 sequence of 21 steps. X10 Mag feature extends maximum sweep speed to 1 ns/div.

Variable Time Control — Continuously variable and calibrated between settings of the Sec/Div switch. Extends slowest A sweep speed to 1.5 s/div. Operates in conjunction with the A Sec/Div switch when A and B are locked together; operates in conjunction with the B Sec/Div switch when A and B are not locked together.

Timing Accuracy*[1]

	Unmagnified	Magnified
A and B Sweep*[2]	±(0.7% of time interval +0.6% of full scale)	±(1.2% of time interval +0.6% of full scale)
ΔTime*[3]	±(0.5% of time +0.3% of full scale)	±(1% of time inteval +0.3% of full scale)

[1] +15°C to +35°C, Sec/Div set to 0.1 s/div or faster.

[2] Time intervals measured at vertical center with Sec/Div Var in detent (0.6% of full scale is 0.06 div).

[3] Time intervals measured with cursors, anywhere on the graticule (A sweep only).

CALIBRATED SWEEP DELAY

ΔTime Accuracy — Time intervals measured with delayed B Sweep with both delays set at 0.5% or more of full scale from minimum delay (no "?" displayed in readout): ±0.3% of time interval +0.1% of full scale.

Delay Accuracy — A Sweep Trigger Point to Start of B Sweep: ±(0.3% of delay setting +0.6% of full scale)—+0 ns, −25 ns.

ΔTime Readout Resolution

2465: Greater of either 10 ps or 0.025% full scale.
2445: Greater of either 20 ps or 0.025% full scale.

ΔTime Range — ±10 times the A Sec/Div switch setting.

Delay Pickoff Jitter — Within 0.004% (one part or less in 25,000) of the maximum available delay, plus 100 ps.

Delay Time Position Range — 0 to 9.95 times the A Sec/Div switch setting. Main sweep triggering event is observable on delayed sweep with minimum delay setting.

TRIGGERING

The minimum p-p signal amplitude for stable triggering is stated for CH 1 or CH 2 source. The signal amplitude for CH 3 or CH 4 source is one-half of CH 1 or CH 2 source specification. For multiple channel source (Alternate Vertical Mode) add 1 div to the single channel source specification.

Dc Coupled — 0.35 div from dc to 50 MHz, increasing to 1 div at 500 MHz (250 MHz for 2445).

Noise Reject Coupled — A voltage level-sensing hysteresis window defined by two levels of p-p signal amplitude. For signals within the vertical bandwidth, triggering *will not* occur (signal reject) with ≤0.4 div. Stable triggering *will* occur with ≤1.2 div from dc to 50 MHz, increasing to 3 div at 500 MHz (250 MHz for 2445).

Ac Coupled — 0.35 div from 60 Hz to 50 MHz, increasing to 1 div at 500 MHz (250 MHz from 2445). Attenuates signals below 60 Hz.

HF Reject Coupled — 0.5 div from dc to 30 kHz.

LF Reject Coupled — 0.5 div from 80 kHz to 50 MHz, increasing to 1 div at 500 MHz (250 MHz for 2445).

Jitter — Less than 50 ps at 300 MHz with A and B Sec/Div set for 5 ns/div sweep and 10X Mag on (100 ps at 150 MHz and 10 ns/div for 2445).

Level Control Range — CH 1 or CH 2: ±18 times the Volt/Div setting. CH 3 or CH 4: ±9 times the Volts/Div setting.

Level Control Readout and Range Accuracy (for Triggering Signals with Transition Times >20 ns) — CH 1 or CH 2 Source (Dc Coupled): +15°C to +35°C is within ±[3% of setting +3% of p-p signal +0.2 div +(0.5 mV x probe attenuation factor)]. −15°C to +55°C (excluding +15°C to +35°C) add (1.5 mV x probe attenuation factor). For noise reject coupled add ±0.6 div to the dc coupled specification. CH 3 or CH 4 Source (Dc Coupled): Within ±[3% of setting +4% of p-p signal +0.1 div +(0.5 mV x probe attenuation factor)]. For noise reject coupled add 0.3 div.

Slope Selection — Conforms to trigger-source waveform or ac power-source waveform.

Auto Level Mode Maximum Triggering Signal Period — With A Sec/Div Switch Setting less than 10 ms: At least 20 ms. A Sec/Div Switch Setting from 10 ms to 50 ms: At least four times the A Sec/Div switch setting. A Sec/Div Switch Setting from 100 ms to 500 ms: At least 200 ms.

Auto Mode Maximum Triggering Signal Period — With A Sec/Div Switch Setting Less than 10 ms: At least 80 ms. A Sec/Div Switch Setting from 10 ms to 50 ms: At least 16 times the A Sec/Div switch setting. A Sec/Div Switch Setting from 100 ms to 500 ms: At least 800 ms.

Auto Level Mode Trigger Acquisition Time — 8 to 100 times the Auto Level mode maximum triggering-signal period, depending on the triggering-signal period and waveform.

A Trigger Holdoff — An adjustable control permits a stable presentation of repetitive complex waveforms. Extends A sweep holdoff to at least 10 times Sec/Div setting. Fully clockwise B sweep ends A sweep.

PORTABLE OSCILLOSCOPES

NEW

X-Y OPERATION

CH 1 supplies the X-axis (horizontal) deflection signal; and any or all of the vertical channels (including CH 1) may supply the Y-axis (vertical) deflection signal.

X Axis Deflection Factor — Range: Same as CH 1. Variable Range: Same as CH 1. Accuracy: Same as CH 1.

X Axis Bandwidth — Dc to 3 MHz.

Input Z — Same as CH 1.

Phase Difference Between X and Y with 20 MHz Bandwidth Limit Off — 1° or less from dc to 1 MHz. 3° or less from 1 MHz to 2 MHz.

X Axis Low-Frequency Linearity — 0.2 div or less compression or expansion of a 2 div, center-screen signal when positioned within the display area.

CURSOR AND FRONT PANEL DISPLAY

Cursor Position Range — ΔV: At least the center 7.6 vertical div. ΔTime: At least the center 9.6 horizontal div.

Power Down Memory — At power down the front panel settings will be stored in memory (EAROM) providing ≤10 s of operating time has occurred.

Z-AXIS INPUT

Sensitivity — Positive voltage decreases intensity. Dc to 2 MHz: +2 V blanks a maximum intensity trace. 2 MHz to 20 MHz: +2 V modulates a normal intensity trace.

Input Resistance — 9 kΩ ±10%.

Maximum Input Voltage — ±25 V peak; 25 V p-p ac at 10 kHz or less.

SIGNAL OUTPUTS

Calibrator — Output Voltage and Current: 0.4 V ±1% into a 1 MΩ load, 0.2 V ±1.5% into a 50 Ω load, or 8 mA ±1.5% into a short circuit, with A Sec/Div switch set to 1 ms/div. Repetition Period: Two times the A Sec/Div switch setting within the range of 200 ns to 200 ms. Accuracy is ±0.1% measured with the Sgl Seq A Trigger Mode selected. Symmetry: Duration of high portion of output cycle is 50% of the output period ±(lesser of 500 ns or 25% of period). Jitter of Pulse Period or Pulse Width: 10 ns or less.

CH 2 Signal Out — Output Voltage: 20 mV/div ±10% into 1 MΩ, 10 mV/div ±10% into 50 Ω. Offset: ±10 mV into 50 Ω when dc balance has been performed within ±5°C of the operating temperature.

A Gate Out and B Gate Out — Output Voltage: 2.4 V to 5 V positive going pulse, starting at 0 V to 0.4 V. Output Drive: Will supply 400 μA during HI state; will sink 2 mA during LO state.

CRT READOUT AND WAVEFORM INFORMATION

Your eyes never have to leave the screen to obtain front panel settings and meaurement results.

In the CRT example above, the top area of the display provides trigger source, trigger voltage level, and Δtime results. The lower area displays the selected volts/div and seconds/div scale factors and that bandwidth limit and holdoff are activated.

DISPLAY

CRT — 80 mm x 100 mm (8 cm x 10 cm).
Standard Phosphor — GH (P31) is standard.
Nominal Accelerating Potential — 16 kV.

AC POWER SOURCE

Voltage Ranges — 115 V: 90 V to 132 V. 230 V: 180 V to 250 V.

Source Frequency — 48 Hz to 440 Hz.

Power Consumption — Typical: 70 W (140 VA). Maximum: 120 W (180 VA).

ENVIRONMENTAL CHARACTERISTICS

The 2465/2445 Oscilloscopes meet or exceed the environmental requirements of MIL-T-28800C for Type III, Class 3, Style C equipment, tested for humidity 4.5.5.1.2.2, low temperature 4.5.5.1.3 and high temperature 4.5.5.1.4.

Safety — UL 1244 and CSA approval.

Electromagnetic Compatibility — Meets MIL-STD-461B Part 2.

Temperature — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

Altitude — Operating: To 4600 m (15,000 ft). Maximum operating temperature decreases 1°C for each 1,000 ft above 5,000 ft. Nonoperating: To 15 200 m (50,000 ft).

Humidity — Operating and Nonoperating: Stored at 95% relative humidity for 5 cycles (120 hours) from +30°C to +60°C, with operational performance checks at +30°C and +55°C.

Dripproof — With Cover On: Meets MIL-T-28800C Para. 4.5.5.5.3.

Vibration — Operating: 15 minutes along each of three axes at a total displacement of 0.025 inch p-p (4 g at 55 Hz), with frequency varied from 10 Hz to 55 Hz in one-minute sweeps. Held 10 minutes at each major resonance, or if none existed, held 10 minutes at 55 Hz (75 minutes total test time).

Shock — Operating and Nonoperating: 50 g's, half-sine, 11 ms duration, three shocks on each face, for a total of 18 shocks.

Transit Drop — Not in Shipping Package: 12 inch drop on each corner and each face (MIL-T-28800C, para 4.5.5.4.2).

Bench Handling — With and Without Cabinet Installed: MIL-STD-810C, Method 516, Procedure V (MIL-T-28800C, para 4.5.5.4.3).

Topple — Operating and Cabinet Installed: Set on rear feet and allowed to topple over onto each of four adjacent faces.

Packaged Transportation Drop — Meets the limits of the National Safe Transit Association Test Procedure 1A-B-2; 10 drops of 36 inches.

Packaged Transportation Vibration — Meets the limits of the National Safe Transit Association Test Procedure 1A-B-1; excursion of 1 inch p-p at 4.63 Hz (1.1 g) for 30 minutes.

PHYSICAL CHARACTERISTICS

	Cabinet		Option 1R Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width			483	19.0
(with handle)	330	13.0		
Height			178	7.0
(with feet/pouch)	190	7.5		
(without pouch)	160	6.3		
Depth			419	16.5
(with front panel cover)	434	17.1		
(with handle extended)	505	19.9		
Weights	**kg**	**lb**	**kg**	**lb**
Net (w/o accessories & pouch)	9.3	20.5	13.3	29.3
(with accessories & pouch)	10.2	22.4	14.2	31.2
Shipping	12.8	28.2	19.1	42.0

Rackmount 2465 Option 1R, comes complete with slide-out chassis tracks.

INCLUDED ACCESSORIES

Two P6131 10X 1.3 m probes with accessories (010-6131-01); ziploc accessory pouch (016-0537-00); blue plastic CRT filter (378-0199-00); clear plastic CRT filter (378-0208-00); snap accessory pouch (016-0692-00); 2 A-250 V fuse (159-0021-00); front cover (200-2742-00); power cord (161-0104-00). 2445 operator manual; service manual; and reference card. 2465 operator manual; service manual; and reference card. Option 1R: Rackmounted instruments also include mounting hardware and slide out assemblies, does not include pouch.

ORDERING INFORMATION

2465 300 MHz Oscilloscope **$4,750**
2445 150 MHz Oscilloscope **$3,250**

INSTRUMENT OPTIONS

The 2465 and 2445 oscilloscopes can be configured with the following factory installed options

Option 1R — Configure Oscilloscope for Rackmount **$275**

Option 11 — Rear Panel Probe Power Connectors (2465 Only) **$155**

Option 22 — Two Additional P6131 Probes **$175**

2465 Option 1R and Option 11 Extender Cables — Order 020-0103-00.

2465/2445 Option 1R Extender Cables — Order 020-0104-00.

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLANS—Refer to page 41**

M1 — (2465) 2 Calibrations **$250**
M1 — (2445) 2 Calibrations **$240**
M2 — (2465) 2 Years Service **$220**
M2 — (2445) 2 Years Service **$170**
M3 — (2465) 2 Years Service and 4 Calibrations **$645**
M3 — (2445) 2 Years Service and 4 Calibrations **$595**

OPTIONAL ACCESSORIES

Protective Waterproof Blue Vinyl Cover — Order 016-0720-00 ..... **$20**

Probe Package — P6131 for Use with Channels 3 or 4. Order 010-6131-01 ..... **$135**

P6230 — 10X Bias/Offset Active Probe. Order 010-6230-01 ..... **$385**

Rackmounting Conversion Kit — Order 016-0691-00 ..... **$255**

Rear Support Kit — For Use with Rackmounted Instruments required to meet MIL-T-28800C. Order 016-0096-00 ..... **$30**

Polarized Collapsible Viewing Hood — Order 016-0180-00 ..... **$40**

Folding Light Shielding Viewing Hood — Order 016-0592-00 ..... **$12**

Collapsible Binocular Viewing Hood — Order 016-0566-00 ..... **$15**

Oscilloscope Camera — See C-30B Option 01.

SCOPE-MOBILE Cart — See 200D or 200C.

Carrying Strap — Order 346-0199-00 ..... **$15**

Additional accessories begin on page 421.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

2335

2335/2336/2337

Dc to 100 MHz Bandwidth

5 mV/div to 5 V/div

5 ns/div Sweep Rate

Rugged for Field Service

Three Year Warranty—Five Year Option

Compact and lightweight for ultra-portability, these oscilloscopes are designed and built for on-site trouble-shooting. The 2335, 2336, and 2337 are useful for high speed logic and digital applications. They feature an innovative and protective flip-top cover that doubles as a front panel with ΔTime on the 2336 and ΔTime/DMM on the 2337 versions. The entire outside case of all three instruments is made of durable, one-piece aluminum and the front panels are coated with scratch resistant plastic. When the flip-tops are latched shut, the entire scope can withstand the abuse and heavy usage of field service environments.

Vertical channels have calibrated deflection factors from 5 mV/div to 5 V/div with a variable gain control to increase the sensitivity to at least 2 mV/div. An internal delay line permits observation of the leading edge of a waveform. Variable sweep speeds range from 0.5 s/div to 50.0 ns/div and a 10X magnifier can increase the sweep rate to 5 ns/div. An auto-trigger mode allows triggering on waveforms with repetitive rates down to approximately 10 Hz. The sweep rate will run freely and provide a base line trace in the absence of an adequate trigger signal.

Many exterior features have been incorporated into these new ultra-portable scopes to make them fast and convenient to use. The CRT produces bright, high resolution traces that are readily visible in most light conditions. The ΔTime/DMM readouts are distinct, backlighted LCD (Liquid Crystal Displays) for clear viewing in any lighting condition. All knobs and switches have been located in logical groupings to avoid errors and delays during operation. And for the 2336 and 2337 models, ΔTiming and DMM display and controls are in the hinged, fliptop cover.

All three oscilloscopes come with detachable power cord, integral EMI shielding, and an accessories pouch. They are manufactured to withstand impact shocks of 50 g's, almost twice that of other portable scopes from Tektronix. This ruggedness meets MIL-T-28800, Class 3 environmental requirements for aerospace and military qualification.

In strong testimony of the incomparable reliability of the 2000 Family oscilloscopes, Tek offers the industry's first three year warranty: All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

CHARACTERISTICS

The following characteristics are common to the 2335, 2336, and 2337 Oscilloscopes except where indicated.

VERTICAL DEFLECTION (TWO IDENTICAL CHANNELS)

Bandwidth*1 and Risetime

−15°C to +40°C	+40°C to +55°C
Dc to at least 100 MHz, 3.5 ns	Dc to at least 85 MHz, 4.15 ns

1 Measured at −3 dB point at all deflection factors from a 50-Ω source terminated in 50 Ω. Bandwidth may be limited to ≈20 MHz by bandwidth limit switch.

Lower −3 dB Point (Ac Coupling) 1X Probe — 10 Hz or less; 10X Probe: 1 Hz or less.

Deflection Factor — 5 mV/div to 5 V/div. 1-2-5 sequence, accurate ±3%. Uncalibrated, continuously variable between steps and to at least 2 mV/div.

Display Modes — CH 1, CH 2, Add CH 2 (normal and inverted), alternate, chopped (≈275 kHz rate).

Common-Mode Rejection Ratio — At least 10:1 at 50 MHz for common-mode signals of 6 div or less.

Input R and C — 1 MΩ ±2% paralleled by 20 pF ±10%.

Maximum Input Voltage — Ac or dc coupled, 400 V (dc + peak ac) or 500 V p-p ac at 1 kHz or less.

HORIZONTAL DEFLECTION

Time Base A — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 5 ns/div.

Time Base B — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 5 ns/div.

Variable Time Control — Time base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div.

Time Base A and B Accuracy*1

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

1 Full 10 divisions

Display Modes — A, A intensified by B, B delayed.

CALIBRATED SWEEP DELAY

Delay Time Range — Continuous from 50 ns to at least 5 s after start of delaying sweep.

Differential Time Measurement Accuracy

	+15°C to +35°C	−15°C to +55°C
2335	0.75% +0.015 major dial div	1.5% +0.015 major dial div
2336/2337	±1% of reading ±1 count	±2.5% of reading ±1 count

Jitter — 1 part or less in 20,000 (0.005%) of 10 times the A Sweep Time/Div setting.

TRIGGERING

A Trigger Mode — Normal (sweep runs when triggered). Automatic (sweep free runs in absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs once on first triggering event after reset selector is pressed). LED indicates when sweep is triggered and when single sweep is ready.

Sensitivity and Coupling

Coupling	To 25 MHz	At 100 MHz
Dc Internal	0.3 div deflection	1.5 div deflection
Dc External	50 mV	150 mV
Dc External ÷ 10	500 mV	1.5 V
Ac	Requirements increase below 60 Hz	
Ac LF Reject	Requirements increase below 50 kHz	
Ac HF Reject	Requirements increase above 50 kHz	

A Trigger Hold Off — Adjustable control permits a stable presentation of repetitive waveforms.

ΔTime B Trigger Modes (2336 and 2337 Only) — Provides two intensified zones on the CRT trace for differential time measurements. Time difference between the two intensified zones is determined by B Delay Time Position and ΔTime Position controls, and is displayed on the LCD readout.

Runs After Delay — B Sweep starts immediately after the delay time selected by the Delay Time Position control and is independent of B trigger signal.

Triggerable After Adjustable Delay Time — The B Sweep Trigger is sourced from a composite of CH 1 and CH 2; CH 1 only, 2 only or from the Ext Trigger input connector.

Jitter — 1.0 ns or less at 100 MHz and 5 ns/div.

A Trigger View — A spring loaded pushbutton overrides other vertical controls to display the signal used to trigger the A Sweep. This control provides quick verification of the (trigger) signal and permits a time comparison between the vertical input signal and the trigger signal. Deflection Factor is 100 mV/div ±40% (1 V/div with Ext ÷ 10).

Level and Slope — Internal, permits selection of triggering at any point on positive or negative slope of vertical input signal. Level adjustment through at least ±1 V in Ext, through at least ±10 V in Ext ÷ 10.

A Sources — Vertical Mode, CH 1, CH 2, Line, Ext, Ext ÷ 10.
B Sources (2336 and 2337 Only) — ΔTime runs after delay, Vertical Mode, CH 1, CH 2, Ext (all modes ac coupled).
External Inputs — R and C 1 MΩ ±10%, 20 pF ±30%. 400 V (dc + peak ac) or 500 V ac p-p at 1 kHz or less.

X-Y OPERATION

Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical) — 5 mV/div to 5 V/div (1-2-5 sequence), accurate ±5% from 0°C to +40°C, accurate ±8% from −15°C to +55°C. X-axis bandwidth is dc to at least 2 MHz. Y-axis bandwidth is dc to at least 100 MHz. Phase difference between amplifiers is 3° or less from dc to 200 kHz.

DISPLAY

CRT — 8 x 10 div (8 mm/div) display. Horizontal and vertical centerlines further marked in 0.2 div increments. GH (P31) Phosphor standard. 18 kV accelerating potential.
Graticule — Internal, nonparallax, nonilluminated; markings for measurement of risetime.
Beam Finder — Compresses trace to within graticule area to locate an off screen signal.
Z-Axis Input — Positive-going, dc coupled signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 20 MHz.

DIGITAL MULTIMETER (2337 ONLY)

DC VOLTAGE

Full Scale Ranges — 2 V (autoranging to 200 mV); 200 V (autoranging to 20 V); and 500 V.
Resolution — 100 μV at 200 mV full scale.
Accuracy

+15°C to +35°C	Within ±0.15% of reading ±1 count
−15°C to +15°C	Add 0.01% for every °C below +15°C
+35°C to +55°C	Add ±0.01% for every °C above +35°C
>80% Relative Humidity	Add ±0.25% of reading ±3 counts

Input Resistance — 10 MΩ ±0.25%.
Rejection Ratio — Normal-Mode: 60 dB minutes at 50 Hz and 60 Hz. Common-Mode: 100 dB minutes at dc, 60 dB minutes at 50 Hz and 60 Hz.
Response Time — Within 3 s (no autorange); within 9 s (up range); within 7 s (down range).
Maximum Input Voltage — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

AC VOLTAGE

Full Scale Ranges — 2 V (autoranging to 200 mV); 200 V (autoranging to 20 V); and 350 V.
Crest Factor — (When peak voltage input is <3 times full scale) Six.
Accuracy[*1]

+15°C to +35°C	Within ±3%, ±6 counts[*1], 20 Hz to 20 kHz
−15°C to +15°C	Add ±0.05% for every °C below +15°C
+35°C to +55°C	Add ±0.05% for every °C above +35°C

*[*1] Nonsinewaves: Derate below 50 Hz. For crest factors >3, add +0, −1% of reading.*

Input Impedance — Resistance 10 MΩ ±0.25% in series with input blocking cap. Capacitance (20 V, 200 V, and 350 V range) <150 pF; (200 mV, 2 V range) <220 pF.
Common-Mode Rejection Ratio — 60 dB minimum at 50 Hz and 60 Hz, 2 V range; 53 dB minimum at 50 Hz and 60 Hz, 200 V and 300 V range.
Response Time — Within 3 s (no autorange); within 9 s (up range); within 7 s (down range).
Maximum Input Voltage — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

RESISTANCE

Full Scale Ranges — 2 kΩ (autoranging to 200 Ω); 200 kΩ (autoranging to 20 kΩ); 20 MΩ (autoranging to 2 MΩ).
Resolution — 0.1 Ω.
Accuracy

+15°C to +35°C	Within ±0.5% ±1 count +0.4 Ω
−15°C to +15°C	Add 0.05% for every °C below +15°C
+35°C to +55°C	Add 0.05% for every °C above +35°C
>80% Relative Humidity	Add ±1% of reading ±8 counts

Response Time — <4 s.
Maximum Input Voltage — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

ENVIRONMENTAL CAPABILITIES[*1]

Operating Temperature Range — −15°C to +55°C (forced air ventilation during normal operation).
Operating Temperature Range, Rackadapted (2335 Option 1R Only) — Temperature inside equipment rack must be between −15°C and +55°C. 2335 exhaust fan temperature must not exceed +65°C.
Storage Temperature Range —
2335: −62°C to +85°C.
2236 and 2237: −40°C to +80°C.
Altitude — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).
Vibration (Structural Integrity) — Test samples were subjected to sinusoidal vibration in the X, Y, and Z-axes with the frequency varied from 10 Hz to 55 Hz to 10 Hz in 1 minute cycles for a duration of 15 minutes. Total displacement was 0.025 in p-p at (4 g's at (55 Hz).
Shock — Operating and Nonoperating: Test samples were subjected to 3 shocks, both directions along each axis (X, Y, and Z) for a total of 18 shocks. Peak acceleration of each shock was 50 g's, ½ sine.
Humidity
2335 (Operating and Nonoperating): Test samples were exposed to 120 hrs (5 cycles) of 95% relative humidity as specified in MIL-T-28800B Paragraph 3.9.2.2.
2336 and 2337 Oscilloscope (Operating): Test samples were subjected to 90% relative humidity at 55°C for a maximum of 72 hours.
2336 and 2337 DMM (Operating): Test samples were subjected to 90% relative humidity at 35°C for a maximum of 24 hours and to 70% relative humidity at 50°C for a maximum of 24 hours.
2336 and 2337 Oscilloscope and DMM (Nonoperating): Test samples were subjected to 90% relative humidity at 60°C for 72 hours.
Electromagnetic Compatibility (EMC) — Test samples were found in compliance with the Class 3 requirements of MIL-STD-461A using procedural steps outlined in MIL-STD-462. (Increase RS03 requirements from 1 V/m to 10 V/m) for REO1, use 500 Hz to 30 kHz in place of 30 Hz to 30 kHz.)

*[*1] The 2335 Oscilloscope meets all environmental requirements of MIL-T-28800, Class 3. The 2336 and 2337 Oscilloscopes meet the environmental requirements of MIL-T-28800, Class 3 except as indicated herein to avoid potential damage to the LCD readout.*

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.2 V accurate ±1% from 0°C to +40°C, ±1.5% from −15°C to +55°C.
Power Requirements — Quick-change selector for operation from 100 V to 132 V ac or 200 V to 250 V ac, 48 Hz to 440 Hz. Maximum power consumption is 60 W at 132 V, 48 Hz. Typical power consumption is 35 W at 115 V, 60 Hz. Option 03 provides operation from 90 V to 115 V ac or 180 V to 230 V ac, 48 Hz to 440 Hz.

PHYSICAL CHARACTERISTICS

	2235,2236,2237 Cabinet		2335 Option 1R Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	274	10.8	483	19.0
(with handle)	315	12.4		
Height			133	5.2
(with feet/pouch)	210	8.3		
(without pouch)	135	5.3		
Depth			378	14.9
(with front cover)	430	17.0		
(handle extended)	528	20.8		
Weights (2335)	**kg**	**lb**	**kg**	**lb**
Net (without accessories or pouch)	7.7	17.0	11.7	25.8
Net (with accessories and pouch)	8.6	19.0	12.6	27.8
Shipping	10.6	23.5	16.9	37.3
Weights (2336,2337)	**kg**	**lb**	**kg**	**lb**
Net (without accessories and pouch)	8.0	17.6		
Net (with accessories and pouch)	8.9	19.6		
Shipping	10.9	24.1		

INCLUDED ACCESSORIES

Two P6108 10X Probes (010-6108-03); accessory pouch (016-0674-00); zip lock accessory pouch (016-0537-00); installed, blue CRT implosion shield (337-2760-00);clear CRT implosion shield (337-2781-00); two 1A fuses (159-0022-00); ½ A fuse (159-0025-00); power cord (161-0104-00). 2337 also includes test lead pair (012-0941-00); service manual; operator's manual.

Rackmount 2335 Option 1R

ORDERING INFORMATION

2335 Oscilloscope **$2,795**
2336 Oscilloscope with ΔTime **$2,995**
2336YA Oscilloscope with ΔTime, Elapsed Time Meter, Extra Accessories and Manuals **$3,195**
2337 Oscilloscope with ΔTime and DMM **$3,395**
Option 1R — Rack Conversion (2335 Only) ..... **+$230**
Option 03 — 100/200 V, ac nominal, 48 Hz to 440 Hz .... **NC**

INTERNATIONAL POWER CORDS & PLUG OPTIONS
Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz

***WARRANTY-PLUS* SERVICE PLANS—Refer to Page 41**
M1 — (2335) 2 Calibrations ..... **+$145**
M1 — (2336/2336YA) 2 Calibrations ..... **+$150**
M1 — (2337) 2 Calibrations ..... **+$155**
M2 — (2335) +2 Years Service ..... **+$140**
M2 — (2336/2336YA) +2 Years Service ..... **+$160**
M2 — (2337) +2 Years Service ..... **+$180**
M3 — (2335) 2 Years Service & 4 Calibrations ..... **+$440**
M3 — (2336/2336YA) 2 Years Service & 4 Calibrations ..... **+$460**
M3 — (2337) 2 Years Service & 4 Calibrations ..... **+$480**

OPTIONAL ACCESSORIES
P6122 — 10X Passive Probe
Order 010-6122-01 ..... **$77**
C-5C Option 04 — Camera (includes 016-0359-01 adaptor and flash) **$530**
Rackmounting Conversion Kit — (For 2335 only)
Order 016-0468-00 ..... **$250**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

NEW

2236

2235/2236

Dc to 100 MHz Bandwidth

Integrated Counter/Timer/DMM (2236)

Light Weight

Easy to Use

2 mV Sensitivity

Advanced Trigger System

5 ns/div Sweep Rate

Delayed Sweep Measurements

Large, Bright CRT

New 10X Probes Included

Three Year Warranty—Five Year Option

With the 2235 and 2236 oscilloscopes, Tektronix takes the high-value, high-performance design concept of the 2200 Series even further. Both scopes feature a low price made possible by the 2200 Series' innovative architecture. Yet both scopes offer advanced performance, operational simplicity and—not least—solid reliability. All backed by the industry's first three-year warranty on all parts and labor, including the CRT, excluding probes.

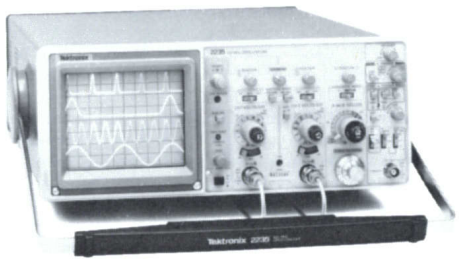
The 100 MHz 2236 introduces a new concept in waveform measurement: a 100 MHz counter/timer/DMM, integrated into the scope's vertical, horizontal and trigger systems. Its capabilities simplify setup, heighten measurement confidence and expand scope versatility in innumerable ways. In one application after another, the 2236 replaces mental gymnastics and roundabout problem-solving with simple, direct, accurate, digital readouts that supplement your analog measurements.

The TEK 2235

The 2235 ensures measurement quality and reliability while reducing instrument cost. Tek started with the innovative architecture of the 2200 Series: fewer boards, fewer mechanical parts, less cabling and electrical connectors. This approach, plus advanced circuit design and a focus on essential features, has led to a scope that's more accurate, more reliable, lighter and more serviceable—and simpler to use—than any other 100 MHz scope.

The 2235 delivers 2% vertical and horizontal accuracy in normal operation. Accuracy of 3% or better is maintained across a wide range of environmental extremes. Trace noise, chop noise, vertical aberrations and sweep interference have been reduced to a minimum. Delay jitter of 1:20,000 ensures excellent timing measurement resolution. Triggerring is sensitive to 0.3 div at 10 MHz. There's a trigger view for simplifying setup; single sweep for photographing transients; and a new, bright, high-resolution 14 kV dome mesh CRT.

2235



Features like rugged design, light weight and easily learned front panel make the 2235 an ideal service scope. In both service and design, it offers the sensitivity for low level measurements and sweep rates for fast logic families, plus 10:1 variable holdoff range for complex word triggering. And at the bottom line, it offers the price and reliability to significantly lower the cost of owning a quality scope.

The TEK 2236

The Tek 2236 adds even easier, more accurate and more versatile measurements through microprocessor-driven waveform analysis. While it's not unusual for a scope to include a bolt-on DMM or other outboard peripheral, the 2236 makes counter/timer/DMM-type measurements through the scope system itself. This makes possible consolidated setups and combinations of measurements that have always been desirable but never possible before.

Traditionally, for example, gated measurements have been possible only by laborious knob-tweaking and mental calculations. Getting results was difficult at best.

But with the 2236, an operator uses intensified markers on-screen to define the area to be measured on a burst or short-duration pulse train. Gated counter measurements are made via the B trigger with operator prompting and automatic, digital readout of results. With period averaging the 2236 can make low frequency measurements instantly, in contrast to the several seconds delay encountered on conventional counter/timers.

Yet speed never comes at the expense of reliability: user confidence is continually enhanced.

The scope and DMM also can be applied simultaneously, with concurrent CRT and digital readout displays. The same probe that feeds data to the scope also provides information to the DMM, so there's no tangle of leads, no extra setup time required to obtain ac or dc voltage.

DMM auto ranging simplifies setup. An ohmmeter range of 2 GΩ—a hundred times the range of most such devices—lets the service technician quickly pinpoint even small amounts of transformer leakage, for example, or allows designers to check the insulating property of capacitors more accurately than ever before.

Designers and service people can both do a lot with the 2236, without learning a lot to do it. Frequency, period and width measurements are push-button simple, with accuracies to 0.001% and beyond. On-screen operator prompts further ensure fail-safe setup. An audible, automatic diode/junction detection signal saves both time and interpretation errors by allowing the operator to concentrate on probing rather than on observing the front panel.

The 2236 is designed for wide appeal by providing the power to simplify routine service measurements, and at the same time encouraging sophisticated designers towards creative methods of problem-solving.

In strong testimony of the incomparable reliability of the 2000 Family oscilloscopes, Tek offers the industry's first three year warranty: All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

NEW

CHARACTERISTICS

The following electrical characteristics are common to both instruments except where noted.

VERTICAL SYSTEM (2 IDENTICAL CHANNELS)

Bandwidth (—3 dB) and Risetime — 100 MHz and 3.5 ns, derated to 90 MHz at 2 mV/div and outside 0°C to +35°C. Bandwidth Limit: 20 MHz ±10%.

Deflection Factor — 2 mV to 5 V/div at ±2%. Accuracy derated to ±3% outside +15°C to +35°C. Uncalibrated: Continuously variable between steps by at least 2.5:1.

Step Response Aberrations — +4%, −4%, 4% p-p (2 mV to 0.5 V/div), +12%, −12%, 12% p-p (1 to 5 V/div).

Vertical System Operating Modes — CH 1, CH 2, CH 2 Invert, Add, Alt, Chop (500 kHz).

Common-Mode Rejection Ratio — For signals of 6 divisions or less, at least 10:1 @ 50 MHz.

Input R and C — 1 MΩ, 20 pF (2235); ≈22 pF (2236).

Maximum Input Voltage (Ac and Dc Coupled) — 400 V (dc + peak ac) or 800 V (p-p to 10 kHz).

Channel 1/Channel 2 Isolation — 100:1 at 50 MHz.

Trace Shift — ≤0.75 div with V/div switch rotation, ≤1 div with V/div variable, ≤1.5 div with CH 2 Invert.

HORIZONTAL SYSTEM

Sweep Rate — A Time Base: 0.05 μs to 0.5 s/div in 1-2-5 sequence. 10X Mag: 5 ns/div. B Time Base: 0.05 μs to 50 ms/div in 1-2-5 sequence. 10X Mag: 5 ns/div.

Sweep Linearity — ±5% over any two of center 8 divisions.

Accuracy — Magnified: ±3%. Unmagnified: ±2%. Derated outside +15°C to +35°C.

Horizontal Operating Modes — A, alternate (A intensified by B), B.

DELAYED SWEEP

Delay Times — Continuously variable with 10-turn control from <0.5 to >10 divisions.

Differential Delay Dial Accuracy (2235) — ±1% (+15°C to +35°C).

ΔTime Measurement Accuracy (2236) — Max accuracy equal to time base accuracy ±50 ps. Time Base Accuracy With Standard Oscillator: 10 ppm (0.001%); with Option 14 TCXO (Temperature-Compensated Crystal Oscillator): 0.5 ppm (0.00005%).

Delay Jitter — 10,000:1 (0.01%) for 2236; 20,000:1 (0.005%) for 2235.

TRIGGER SYSTEM

A Trigger Sensitivity

2235	Internal	External
10 MHz	0.3 div	35 mV
100 MHz	1.5 div	200 mV
2236		
10 MHz	0.35 div	40 mV
100 MHz	1.5 div	200 mV
2236 CTM		
10 MHz	0.5 div	50 mV
100 MHz	2.0 div	200 mV

B Trigger (Internal Only) Sensitivity — 2235 and 2236 B Sweep: 0.35 div at 10 MHz, 1.5 div at 100 MHz; 2236 CTM: 0.5 div at 10 MHz, 2.0 div at 100 MHz.

Trigger System Operating Modes — Normal, p-p automatic, TV field, and single sweep. Bandwidth limit to 20 MHz ± 10%.

Trigger View System — Same deflection factors as vertical channels with internal sources; 100 mV with ac and dc external, and 1 V/div with dc ÷ 10 external. Accuracy is ±20%. Delay difference between trigger view and either vertical channel is less than 2.0 ns.

External Trigger Input — Coupling: Ac, dc, or dc ÷ 10. Bandwidth: 100 MHz.

Variable Holdoff Control — Increases A sweep holdoff time at least 10:1.

X-Y MEASUREMENTS

Deflection Factors — Same as scope's vertical system with the V/div switch in calibrated detent.

Accuracy

	Y-Axis	X-Axis
+15°C to +35°C	±2%	±3%
0°C to +50°C	±3%	±4%

Bandwidth — Y-Axis: same as scope's vertical system. X-Axis: 3 MHz.

Phase Difference Between X-Axis and Y-Axis Amplifiers — ±3° from dc to 150 kHz with dc coupled inputs.

DISPLAY

CRT — 8 x 10 cm display; internal graticule, unilluminated GH (P31) phosphor is standard; 14 kV nominal voltage.

Controls — Beam finder, focus, separate A and B sweep intensity, trace rotation.

Z-Axis — Sensitivity: 5 V cause noticeable modulation, positive voltage decreases intensity. Useable frequency range is dc to 20 MHz.

2236 Counter/Timer/Multimeter

Using the 100 MHz, microprocessor-controlled 2236, autoaveraged and autoranged counter/timer measurements are made on the signal triggering the A sweep, or in gated modes on the signal triggering the B sweep. Autoranged DMM measurements are made through floating DMM side inputs and up-range at 5000 counts. Channel 1 voltage measurements made on Channel 1 signal include: dc, relative dc, relative and true RMS voltage. CTM measurements are displayed on a 9-digit, 7-segment vacuum-fluorescent panel in engineering notation; audible signals supplement the resistance and continuity measurement messages. Self-testing includes power-on and user interactive routines.

CHARACTERISTICS

Time Base Accuracy — Standard: 10 ppm (0.001%). With Option 14 TCXO: 0.5 ppm (0.00005%).

Frequency — Range: ≤0.2 Hz to ≥100 MHz. Max Resolution: 0.00001 Hz. Max Accuracy: Equal to time base accuracy. Can be gated.*1

Period — Range: ≥5 s to ≤10 ns. Max Resolution: 10 ps. Max Accuracy: Equal to time base accuracy. Can be gated.*1

Width — Range: ≥5 s to ≤5 ns. Max Resolution: 10 ps. Max Accuracy: Equal to time base accuracy ±10 ns. Can be gated.*1

Delay Time — Range: ≥2.5 s to ≤500 ns. Max Resolution: 10 ps. Max Accuracy: Equal to time base accuracy ±2 ns.

Delta Time — Range: ≥2.5 s to ≤1 ns. Max Resolution: 10 ps. Max Accuracy: Equal to time base accuracy ±50 ps.

Totalize — Over 8,000,000 events.

Dc Volts — Range: 0 to 500 V. Max Resolution: 100 μV. Accuracy: To 0.1%. Input: Through side DMM leads.

RMS Ac Volts — Ac Coupled: True RMS with 20 Hz to 20 kHz frequency range. Range: 0 to 350 V. Max Resolution: 100 μV. Accuracy: To 0.1%. Input: Through side DMM leads.

CH 1 Volts — Measures average dc voltage (with CH 1 dc coupling) or true RMS voltage (with CH 1 ac coupling); 1X/10X ranged by coded probes; Single Sweep button zeros display and permits relative dc and ac rms measurements. Range, Dc and Ac Volts: 0 to 50 V (500 V dc/350 V ac with P6121 10X probe). Max Resolution, Dc and Ac Volts: 100 μV (1 mV with P6121). Max Accuracy, Dc Volts (18°C to 28°C): ±0.3% with 1X probe, ±0.5% with 10X probe. Max Accuracy, Ac Volts with 1X Probe (18°C to 28°C): ±2%, 50 Hz to 100 Hz, ±1%, 100 Hz to 20 kHz. Max Accuracy, Ac Volts with 10X Probe: ±2%, 20 Hz to 20 kHz, with proper probe compensation.

Resistance — Range: 0 to 1.99 GΩ. Max Resolution: 0.01 Ω. Accuracy: To 0.15%. Automatic diode detection displays forward voltage drop to ±1%; continuity mode activates tone if resistance is less than 5Ω.

Temperature — Uses optional Tektronix P6602 Temperature Probe. Temperatures in C or F selected with Freq/ΔTime button. Range: −62°C to +230°C. Resolution: To 0.1° (either range). Accuracy: To ±2% of reading ±1.5°C); ±(2% of reading ±2.70°F).

Multimeter Inputs — Isolated from oscilloscope ground. Input Z: 10 MΩ. Max Input Voltage: 500 V (dc + peak ac), for all functions.

**1 Ranges, resolutions, and accuracies can be degraded due to gating errors and a smaller number of automatic averages made during a gated frequency, period, or width measurement.*

ENVIRONMENTAL CHARACTERISTICS

Temperature — Operating: 0°C to +50°C; (except 2236 CTM ac RMSV, DCV, and Ω Modes: 0°C to +40°C). Nonoperating: −55°C to +75°C. Radiated and Conducted Emission Requirements per VDE 0871—Meets Class B.

OTHER CHARACTERISTICS

Power — Voltage: 90 V to 250 V ac. Frequency: 48 Hz to 440 Hz.

PHYSICAL CHARACTERSTICS

	2235		2236	
Dimensions	**mm**	**in**	**mm**	**in**
Width*1	328	12.9	328	12.9
Height	137	5.4	137	5.4
Depth*2	440	17.3	440	17.3
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net	6.1	13.5	7.3	16.2

**1 Without handle.*
**2 Without front cover.*

INCLUDED ACCESSORIES (2235)

Two P6122 10X voltage probes (010-6122-01); service manual; operator's manual.

INCLUDED ACCESSORIES (2236)

Two P6121 10X voltage probes (010-6121-01); DMM leads; operator's manual; service manual.

ORDERING INFORMATION

2235 Oscilloscope **$1,650**

2236 Oscilloscope with Counter/Timer/Multimeter **$2,650**

Option 14 — TCXO Temperature-Compensated Crystal Oscillator ..... +$295

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Order 020-0859-00.

Option A2 — UK 240 V/13 A, 50 Hz
Order 020-0860-00.

Option A3 — Australian 240 V/10 A, 50 Hz
Order 020-0861-00.

Option A4 — North American 240 V/15 A, 60 Hz
Order 020-0862-00.

Option A5 — Switzerland 220 V/10 A, 50 Hz
Order 020-0863-00.

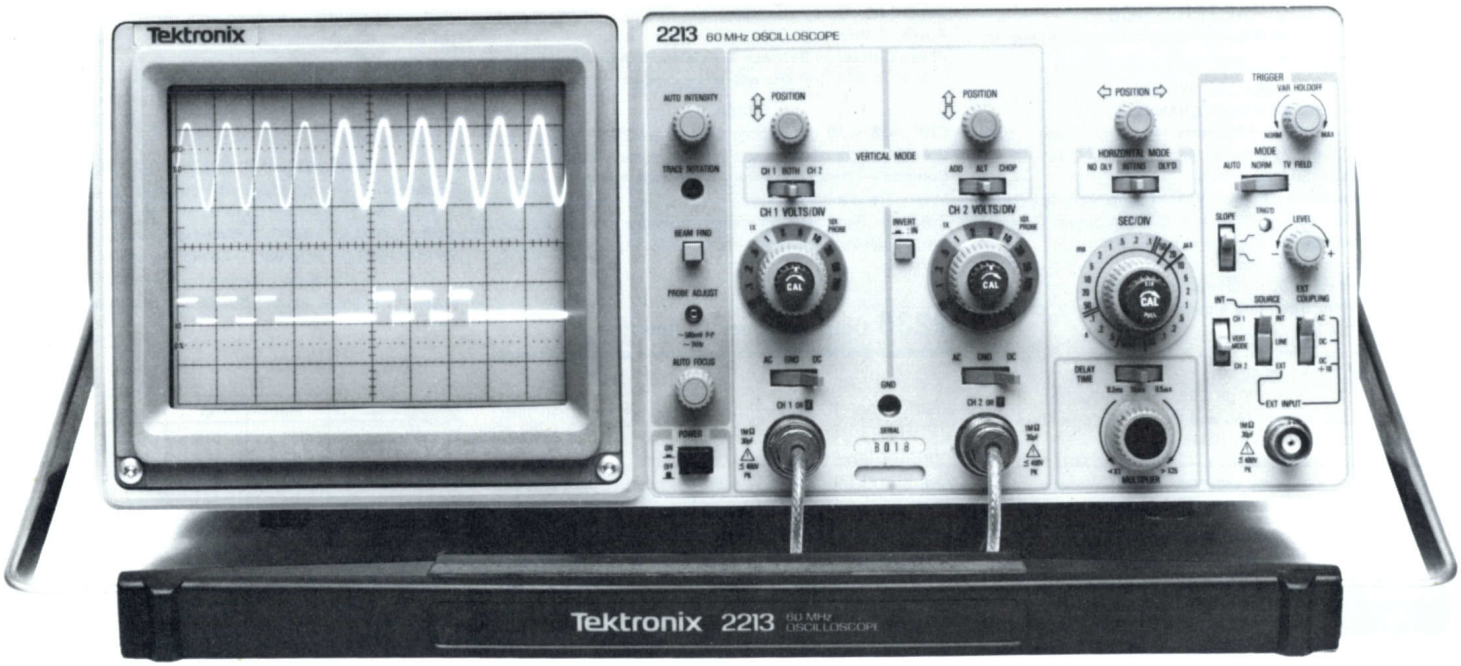
***WARRANTY-PLUS* SERVICE PLANS—Refer to page 41**

M1 — (2235) 2 Calibrations ..... +$135
M1 — (2236) 2 Calibrations ..... +$160
M2 — (2235) +2 Years Service ..... +$115
M2 — (2236) +2 Years Service ..... +$150
M3 — (2235) 2 Years Service & 4 Calibrations ..... +$380
M3 — (2236) 2 Years Service & 4 Calibrations ..... +$475

OPTIONAL ACCESSORIES

Front Panel Cover and Accessory Pouch — Order 020-0672-00 ..... **$47**
Front Panel Cover — Order 200-2520-00 ..... **$5.00**
Accessory Pouch — Order 016-0677-00 ..... **$42**
Viewing Hood — Order 016-0566-00 ..... **$15**
Carrying Strap — Order 346-0199-00 ..... **$15**
Carrying Case — Order 016-0694-00 ..... **$340**
2235 Rack Adaptor Kit — Order 016-0466-00 ..... **$100**
2236 Rack Adaptor Kit — Order 016-0015-00 ..... **$200**
CRT Light Filter (Clear) — Order 337-2775-00 ..... **$3.00**
C-5C Option 04 Scope Camera **$530**
Model 200D or 200C SCOPE-MOBILE® Cart **$320**
P6602 Temperature Probe — For use with 2236 CTM. Order 010-6602-00 ..... **$235**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.



2213/2215

Dc to 60 MHz Bandwidth

Lightweight

Easy to Use

2 mV Sensitivity

Advanced Trigger System

5 ns/div Sweep Rate

Delayed Sweep Measurements

Large, Bright CRT

New 10X Probes Included

Three Year Warranty—Five Year Option

Two 60 MHz, dual trace oscilloscopes from Tektronix offer unprecedented value in both initial and life cycle costs. They are ideal everywhere general purpose scopes are needed.

These oscilloscopes provide unexcelled performance in a small lightweight package; 6.1 kg (13.5 lb). With pouch and front cover, only 6.8 kg (15 lb).

X-Y operation is simple and easy to use. Both vertical input channels (CH 1 and CH 2) can be used through their full range of sensitivity settings. Vertical sensitivities range from 2 mV to 10 V/div. Sweep speeds range from 0.5 s/div to 50 ns/div. A 10X magnification provides 5 ns/div.

A pushbutton beamfinder allows easy scope setups. The scope bezel accepts a Tektronix C-5C Scope Camera with graticule illuminating flash (Option 04).

The advanced triggering system features true vertical mode alternate triggering; both the 2213 and 2215 will trigger alternately even with unrelated signals. Other features include variable trigger holdoff, TV line and TV field triggering at any sweep speed, and an enhanced auto mode. On the 2215, the dual time base operates in either run after A or trigger after A. The latter permits jitter-free B measurements.

The 2213's single time base delay provides the user with the performance of intensified and delayed sweep operations at a low price. Where dual time base performance is required, the 2215 delivers it with alternate sweep switching. The 2215 can display four traces; vertical channels 1 and 2 at the A sweep rate, and vertical channels 1 and 2, delayed, at the B sweep rate. Both scopes also incorporate new auto-intensity and auto-focus circuits that provide convenient operation over a wide range of sweep speeds.

Low life cycle cost is brought about by the inherent reliability of the new scopes. The parts count and cabling have been greatly reduced as compared to older designs. Even the traditional line transformer and line voltage selector switches have been eliminated, thanks to a new high-efficiency power supply. The advantages of these power supply improvements are that the 2213 and 2215 will operate from mains voltages of 90 to 250 V RMS at frequencies from 48 to 440 Hz. Additional reliability also results from superior mechanical design and packaging, soldered-in components, absolute minimum of connectors and very low power consumption.

In strong testimony of the incomparable reliability of the 2000 Family oscilloscopes, Tek offers the industry's first three year warranty: All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

CHARACTERISTICS

The following electrical characteristics are common to both instruments except where noted:

VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

Bandwidth*1 and Risetime*2

0°C to +40°C	+40°C to +50°C
Dc to 60 MHz, 20 mV/div to 10 V/div, 5.8 ns reduced Dc to 50 MHz, 2 mV to 10 mV/div, 7 ns	Dc to 50 MHz, 2 mV to 10 mV/div 7 ns

*1 *Measured at −3 dB.*

*2 *At all deflection factors from 50 Ω terminated source.*

Deflection Factor — 2 mV/div to 10 V/div ±3% (+20°C to +30°C) or ±4% (0°C to +50°C). 1-2-5 sequence. Uncalibrated, continuously variable between steps to at least 25 V/div.

Display Modes — CH 1, CH 2, CH 2 Add (normal and inverted), Alternate, Chopped: ≈250 kHz rate, electronically switched.

Common-Mode Rejection Ratio — At least 10:1 at 10 MHz for common-mode signals of 6 divisions or less.

Input R and C — 1 MΩ ±2% paralleled by ≈30 pF.

Maximum Input Voltage

Dc Coupled	400 V (dc + peak ac) 800 V (p-p ac at 1 kHz or less)
Ac Coupled	400 V (dc + peak ac) 800 V (p-p ac at 1 kHz or less)

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base A (2213 and 2215) — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). 10X magnifier extends max sweep rate to 5 ns/div.

Time Base B (2215 Only) — 0.05 μs/div to 50 ms/div (1-2-5 sequence). 10X magnifier extends max sweep rate to 5 ns/div.

Variable Time Control (2213 and 2215) — Time Base A provides continuously variable uncalibrated sweep rates between steps to at least 1.25 s/div.

Time Base A (2213 and 2215) and B (2215 only) Accuracy*1

	+20°C to +30°C	0°C to +50°C
Unmagnified	±3%	±4%
Magnified	±5%	±6%

*1 *Center 8 divisions.*

Horizontal Display Modes (2213) — A, A intensified after delay, delayed.

Horizontal Display Modes (2215) — A, alternate (A intensified by B and B), B. Electronic switching between intensified and delayed sweep.

2213 SWEEP DELAY

Delay Times — <0.5 μs, 10 μs, and 0.2 ms.

Multiplier — Increases delay time by 20 to 1 or more.

Jitter — 5000 to 1 (0.02%) of maximum available delay time.

2215 SWEEP DELAY

Delay Times — Continuously variable by means of a 10 to 1 vernier control. Delayed (B) portion is intensified on the main (A) trace.

Delay Position Range — <0.5 div +300 ns to more than 10 div.

Delay Dial Accuracy — ±1.5% of reading past 1 div.

A/B Sweep Separation — Control permits main and delayed sweep to be separated by at least 3.5 div.

Jitter — 10,000 to 1 (0.01%) of maximum available delay time.

TRIGGERING

2213 and 2215 A Time Base Trigger Modes — Normal (sweep runs when triggered), automatic (sweep runs in the absence of a triggering signal and triggers automatically for signals down to 20 Hz), and TV field (with slope set for negative going transitions, and trigger level adjusted close to blanking level, sweep starts at first line of video; use Normal for TV line display). LED indicates when sweep is triggered.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive complex waveforms.

Sensitivity — Auto and Normal Internal: Below 2 MHz, signal must be at least 0.4 div amplitude; requirements increase above 2 MHz; at 60 MHz, signal must be at least 1.5 div amplitude.

Auto and Normal External — Up to 2 MHz, trigger signal must be at least 50 mV p-p; requirements increase up to 60 MHz, where signal must be at least 250 mV p-p.

TV Field — Composite video must be at least 2 div amplitude.

Level and Slope (Norm Mode) — Internal: Trigger level can be adjusted over the range of amplitudes displayed on the CRT. External, Dc Coupled: Level can be adjusted over a range of at least ±2 V, or 4 V p-p. External, Dc Coupled and Attenuated (÷ 10): Level can be adjusted over a range of at least ±20 V, or 40 V p-p.

External Inputs — R and C ≈1 MΩ paralleled by ≈30 pF. 400 V (dc + peak ac) or 800 V ac p-p at 1 kHz or less.

2215 DELAYED (B) TIMEBASE

Level and Slope — Separate slope and level controls for triggering B sweep.

Sensitivity — Up to 2 MHz, signal must be at least 0.4 div in vertical amplitude; requirements increase up to 60 MHz, where signal must be at least 2 div in amplitude.

X-Y OPERATION

Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical) — 2 mV/div to 10 V/div, accurate ±5%. Bandwidth is dc to at least 2 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz.

DISPLAY

CRT — 8 x 10 cm display. Horizontal and vertical center lines further marked in 0.2 cm increments. GH (P31) Phosphor standard. 10 kV accelerating potential, mesh grid, halo suppressed.

Graticule — Internal, non-parallax, not illuminated; markings for measurement of risetime.

Beam Finder — Compresses trace to within graticule area for ease in locating an off-screen signal. A preset intensity level provides a constant brightness.

Z-Axis Input — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 5 MHz.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: To 4600 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating test samples were subjected to sinusoidal vibration in the X, Y, and Z axis with the frequency varied from 10 Hz to 55 Hz to 10 Hz in 1 minute sweeps for a duration of 15 minutes per axis and a dwell of 10 minutes at 55 Hz. Total displacement was 0.015 in p-p (2.4 g's at 55 Hz).

Humidity — Operating and Nonoperating: Test samples were subjected to 5 cycles (120 hours) of humidity testing.

Shock — Operating and Nonoperating: Test samples were subjected to 3 shocks, both directions along each axis for a total of 18 shocks. Peak accelerations of each ½-sine shock were 30 g's.

OTHER CHARACTERISTICS

Probe Adjust Signal — Squarewave, 0.5 V ±20%, 1 kHz ±20%.

Power Requirements — 90 to 250 V, 48 to 440 Hz without range switching, 50 W maximum at 115 V and 60 Hz.

PHYSICAL CHARACTERISTICS

Cabinet Dimensions	mm	in
Width (with handle)	360	14.2
Width (without handle)	237	12.9
Height (with feet and handle)	137	5.4
Depth (with front cover)	445	17.5
Depth (without front cover)	440	17.3
Depth (with handle extended)	511	20.1
Weights ≈	**kg**	**lb**
Net (with cover accessories, and pouch)	7.6	16.8
Net (without cover accessories, and pouch)	6.1	13.5
Shipping (domestic)	8.2	18.0

INCLUDED ACCESSORIES

Two P6122 10X voltage probes (010-6122-01); operator's manual, service manual.

ORDERING INFORMATION

2213 Single Time Base Oscilloscope with Delayed Sweep **$1,200**

2215 Delayed Alternate Time Base Oscilloscope **$1,450**

Power Cords — Standard: 110 V ac North American plug.

INTERNATIONAL POWER CORDS & PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz.
Order 020-0859-00.

Option A2 — UK 240 V/13 A, 50 Hz.
Order 020-0860-00.

Option A3 — Australian 240 V/10 A, 50 Hz.
Order 020-0861-00.

Option A4 — North American 240 V/15 A, 60 Hz.
Order 020-0862-00.

Option A5 — Switzerland 220 V/10 A, 50 Hz.
Order 020-0863-00.

***WARRANTY-PLUS* SERVICE PLANS—Refer to page 41**

M1 — (2213) 2 Calibrations ..... +$95
M1 — (2215) 2 Calibrations ..... +$100
M2 — (2213) +2 Years Service ..... +$75
M2 — (2215) +2 Years Service ..... +$80
M3 — (2213) 2 Years Service & 4 Calibrations ..... +$250
M3 — (2215) 2 Years Service & 4 Calibrations ..... +$270

OPTIONAL ACCESSORIES

Front Panel Cover — Order (200-2520-00) **$5.00**
Accessory Pouch — Order (016-0677-00) **$42**
Pouch and Cover — Order (020-0672-00) **$47**
Viewing Hood — Order (016-0566-00) **$15**
Carrying Strap — Order (346-0199-00) **$15**
Carrying Case — Order (016-0694-00) **$340**
CRT Light Filter — Clear. Order (337-2775-00) **$3.00**
C-5C Option 04 — Scope Camera **530**
Model 200D or 200C SCOPE-MOBILE® Cart **$320**
Rack Adaptor Kit — Order (016-0466-00) **$100**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

TEK 100 MHz DUAL TRACE TRI-SERVICE STANDARD OSCILLOSCOPE

465M or AN/USM-425 (v)1

Fully Provisioned Through the Federal Supply System

Meets MIL-T-28800, Type II, Class 4, Style C for the Environmental Conditions Listed

100 MHz at 5 mV/div, Dual Trace, Delayed Sweep

Accepted and Specified by All Branches of the Military and by Several Civil Agencies

If you're a contractor involved in designing and specifying systems for the government, here's a 100 MHz oscilloscope that should top your recommended support equipment list—the Tektronix 465M Portable Oscilloscope.

The Tektronix 465M is the AN/USM-425 (v) 1 tri-service standard 100 MHz portable oscilloscope. The instrument is accepted, fully provisioned, and supported throughout the Federal Supply System. Because the MIL manuals and support documentation are already complete, your required paper work is greatly reduced and it's much simpler for the government to accept your recommendations.

You can now order the 465M directly from your Tektronix Sales Engineer with the AN/USM-425 (v) 1 nomenclature by simply specifying Option 49. This assures the fastest possible delivery of your AN/USM-425 (v) 1.

CHARACTERISTICS

VERTICAL SYSTEM

Bandwidth and Risetime — Dc to at least 100 MHz (−3 dB) and risetime 3.5 ns or less for dc coupling and −15°C to +55°C. For ac coupling the lower 3 dB point is 10 Hz or less with a 1X probe and 1 Hz or less with a 10X probe.

Bandwidth Limit Mode — Bandwidth limited to 20 MHz.

Deflection Factor — 5 mV/div to 5 V/div in 10 steps (1-2-5 sequence). Dc Accuracy: ±2% 0°C to +40°C; ±3%, −15°C to 0°C, +40°C to +55°C. Uncalibrated, continuously variable between settings, and to at least 12.5 V/div.

Common-Mode Rejection Ratio — 25:1 to 10 MHz; 10:1 from 10 MHz to 50 MHz, 6 cm sinewave, (Add Mode with CH 2 inverted.)

Display Modes — CH 1, CH 2 (normal or inverted), alternate, chopped (250 kHz rate), added, X-Y.

Input R and C — 1 MΩ ±2%, ≈20 pF.

Maximum Input Voltage — Dc or Ac Coupled: ±250 V dc + peak ac at 50 kHz, derated above 50 kHz.

Cascaded Operation — (CH 2 Out into CH 1), Bandwidth, dc to at least 40 MHz. Sensitivity: ≈1 mV/div when terminated in 50 Ω at CH 1 input with both CH 1 and CH 2 V/div switches set to 5 mV/div.

HORIZONTAL DEFLECTION

Time Base A — 0.5 s/div to 0.05 μs/div in 22 steps (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 5 ns/div.

Time Base B — 50 ms/div to 0.05 μs/div in 19 steps (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 5 ns/div.

	Unmagnified	Magnified
+20°C to +30°C	±2%	±3%
−15°C to +55°C	±3%	±4%

Mixed Sweep Accuracy — A Portion: ±4%. B Portion: ±2%.

Horizontal Display Modes — A, A intensified by B, B delayed by A, and mixed.

CALIBRATED SWEEP DELAY

Calibrated Delay Time — Continuous from 0.1 μs to at least 5 s after the start of the delaying A sweep.

Differential Time Measurement Accuracy — For Measurements of Two or More Major Dial Divs: +15°C to +35°C, 1% + 0.1% of full scale. 0°C to +55°C, additional 1% allowed.

Jitter — One part or less in 20,000 (0.005%) of 10 the A Time/Div switch setting.

TRIGGER

A Trigger Modes — Normal Sweep is triggered by an internal vertical amplifier signal, external signal, or internal power line signal. A bright baseline is provided only in presence of trigger signal. Automatic: A bright baseline is displayed in the absence of input signals. Triggering is the same as normal mode above 40 Hz. Single (main time base only): The sweep occurs once with the same triggering as normal. The capability to rearm the sweep and illuminate the reset lamp is provided. The sweep activates when the next trigger is applied for rearming.

A Trigger Holdoff — Increases A sweep holdoff time to at least X10 the Time/Div settings, except at 0.2 s and 0.5 s.

Triggering Sensitivity and Coupling

Coupling	From 30 Hz to 25 MHz	At 100 MHz
Dc Internal	0.3 div	1.0 div
Dc External	50 mV	150 mV
Ac	Attenuates signals below 30 Hz	
Ac LF Reject	Attenuates signals below 15 kHz	
Ac HF Reject	Attenuates signals below 50 kHz	

Jitter — 0.5 ns or less at 100 MHz and 5 ns/division, −15°C to +55°C.

Trigger View — View external and internal trigger signals; Ext 1X, 100 mV/division, Ext ÷10, 1 V/division.

Level and Slope — Internal, permits triggering at any point on the positive or negative slopes of the displayed waveform. External, permits continuously variable triggering on any level between +1.0 V and −1.0 V on either slope of the trigger signal.

A Sources — CH 1, CH 2, Normal (all display modes triggered by the combined waveforms from CH 1 and 2), Line, Ext, Ext ÷10.

B Sources — B starts after delay time; CH 1, CH 2, Normal, Ext, Ext ÷10.

X-Y OPERATION

Sensitivity — 5 mV/divison to 5 V/division in 10 steps (1-2-5 sequence) through the vertical system. Continuously variable between steps and to at least 12.5 V/division.

X-Axis Bandwidth — Dc to at least 4 MHz.

Y-Axis Bandwidth — Dc to 100 MHz.

X-Y Phase — <3° from dc to 50 kHz.

SIGNAL OUTPUTS

A Gate — ≈5.0 V positive-going pulse.

B Gate — ≈5.0 V positive.

DISPLAY

CRT — 5 inch rectangular tube; 8 x 10 cm display; GH (P31) Phosphor is standard.

Graticule — Internal, nonparallax; illuminated. 8 x 10 cm markings with horizontal and vertical center lines further marked in 0.2 cm increments. 10% and 90% markings for rise-time measurements.

Graticule Illumination — Provides variable illumination from 0 to greater than optimum illumination.

Beam Finder — Limits the display to within the graticule area and provides a visible display when pushed.

Z-Axis Input — A female BNC connector is provided to permit intensty modulation over the dc to 15 MHz range. At optimum intensity, intensity modulation is accomplished with a Z-axis input of from −5 V (to intensify) to +5 V (to blank). Continuous operation maximum input shall be ±50 V (dc + peak ac).

ENVIRONMENTAL CHARACTERISTICS

EMC — Complies with the following limits as specified in MIL-T-28800B. CE01 (10 kHz to 20 kHz only), CE03, CS01, CS02, CS06, RE01 (relaxed 10 dB at fundamental, third harmonic, and fifth harmonic of the power source frequency) RE02 (limited to 7 GHz), RS01 and RS03 (limited to 1 GHz).

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

Altitude — Operating: To 4600 m (15,000 ft). Maximum operating temperature decreased 1°C/1,000 ft 5,000 to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

Vibration — Operating (Along Each of the Three Major Axes): Cycling 5 Hz to 25 Hz to 5 Hz for 10 minutes at 0.025 in p-p; Cycling 25 Hz to 55 Hz to 25 Hz for 5 minutes at 0.020 in p-p; Dwelled at 55 Hz for 10 minutes at 0.020 in p-p. Total Vibration Time: 75 minutes.

Humidity — Operating and Nonoperating: 5 cycles (120 hours) referenced to MIL-E-16400F.

Shock — Operating: 30 g's, ½ sine, 11 ms duration, 3 shocks each direction per axis for a total of 18 shocks.

OTHER CHARACTERISTICS

Calibrator Output Voltage — 1.0 V ±1.0% to −15°C to +55°C. Frequency: ≈1 kHz.

Channel 2 Signal Output — Through main module CH 2 Out connector. Output Voltage: ≈50 mV/division into 1 MΩ, ≈25 mV/division into 50 Ω. Output Resistance: ≈50 Ω. Bandwidth: Dc to at least 40 MHz into 50 Ω.

Power Requirements — 100 V to 132 V RMS, 200 V to 264 V RMS. 48 Hz to 440 Hz. Maximum power consumption 60 W at 115 V, 60 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width (with handle)	347	13.6
Width (without handle)	317	12.5
Height (with feet)	179	7.0
Depth (including panel cover)	546	21.5
Depth (handle extended)	611	24.1
Weight ≈	**kg**	**lb**
Net (w/o cover and accessories)	10.9	24.0
Net (with panel cover, modules, and accessories)	12.2	27.0
Shipping	15.5	34.2

Transportation — Meets the limits of National Safe Transit Committee test procedure 1A with a 30 inch drop.

INCLUDED ACCESSORIES

Two P6104 10X probes (010-6104-00); accessory and cover assembly (200-2055-01); P6101 1X probe (010-6101-00); three pincer tips (013-0107-03); T connector (103-0030-00); two UHF male to BNC female adaptors (103-0015-00); two BNC male to UHF female adaptors (103-0032-00); BNC male to dual binding post adaptor (103-0035-00); three banana tips (134-0013-00); three probe tip adaptors (103-0051-01); three 6 inch leads with spring clips (175-0124-01); blue filter (337-2122-00); three hooked probe tips (206-0105-00); clear filter (337-2122-01); power cord (161-0118-00); three miniature alligator clips (344-0046-00); service manual; operator's manual.

ORDERING INFORMATION

465M Portable Oscilloscope **$4,010**

Option 49 — AN/USM-425 (v) 1 ..... **NC**

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

OPTIONAL ACCESSORIES

P6022 Current Probe — 9 ft cable with termination.
Order 015-0135-01 ..... **$380**

Folding Polarized Viewing Hood — Order 016-0180-00 **$40**

Mesh Filter — Improves contrast and EMC filtering.
Order 378-0726-01 ..... **$55**

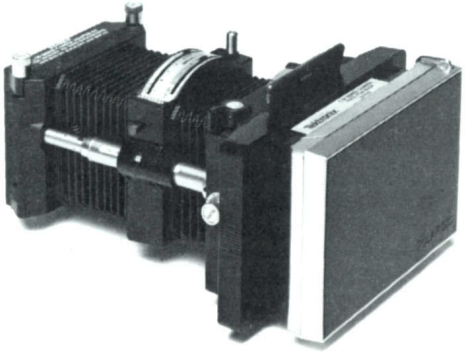
SCOPE-MOBILE® Cart — Occupies <18 inch of aisle space.
Order 200D or 200C **$320**

Rack Adaptor (Cradle Mount) Kit — Rack height 7 in, depth 18.75 in, width 19 in. Order 040-0825-01 ..... **$350**

RECOMMENDED CAMERA

C-30BP Option 01 General Purpose Camera — Includes 016-0301-01 mounting adaptor/corrector lens.
Order C-30BP Option 01 Camera **$1,417**

For further information see camera section.



1105 BATTERY POWER SUPPLY

The 1105 is a rugged, portable power supply suitable for powering virtually any portable oscilloscope in the field. The 1105 is not recommended for the T912.

Frequency — Squarewave, 60 Hz ±10%.

Amplitude — ≈108 V peak, operating from 24 V dc external or 22 V internal charge. ≈137.5 V peak, operating from 28 V dc external or 30 V internal charge.

Amplitude (Option 01) — ≈216 V peak, from 24 V dc external or 22 V internal charge. ≈275 V peak, operating from 30 V dc external or 28 V internal charge.

Charging Power Source — 100 V to 132 V ac, 48 Hz to 440 Hz (or internal connections expand range). Option 01: −200 V ac to 264 V ac, 48 Hz to 440 Hz (or internal connections expand range).

Battery Operating Time — ≈100 W hours.

Recommended Maximum Output Current — 0.9 A.

Weight — 8.8 kg (19.5 lb).

ORDERING INFORMATION

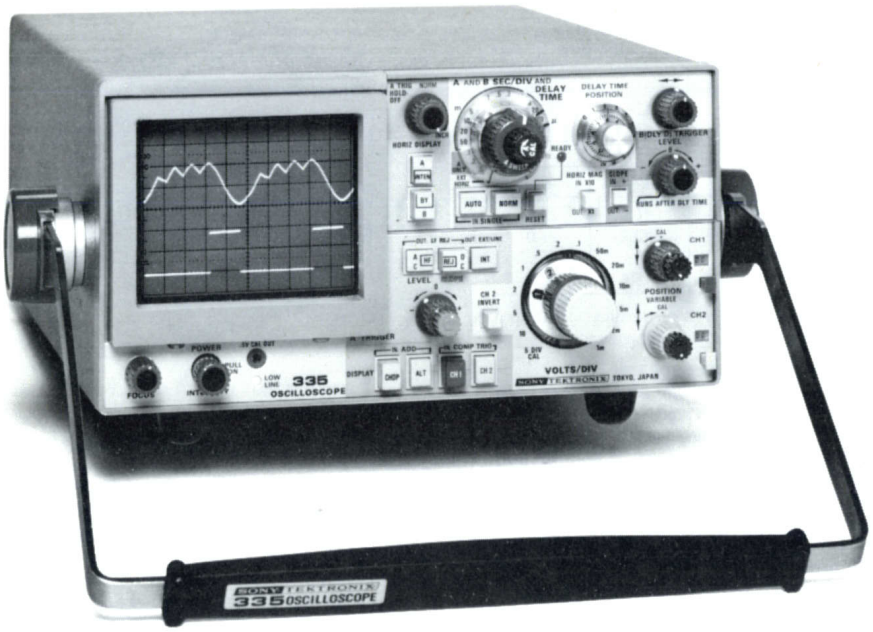
Order 1105 Battery Power Supply **$1,430**

Option 01 — 230 V Operation ..... **NC**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

Tektronix offers service training classes on the 400 Series oscilloscopes. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.

SONY®/TEKTRONIX® 35 MHz DUAL TRACE OSCILLOSCOPE



335

35 MHz at 10 mV/div

Small Size, Weighs ≈4.7 kg (10.5 lb)

1 mV/div Vertical Sensitivity at 25 MHz

Delay Lines Input

Rugged Construction

The portability of the 335 is a big plus in many digital and analog trouble-shooting applications. And it weighs only 10.5 pounds.

1 mV/div (at 25 MHz) vertical sensitivity insures that low level signals from magnetic recording heads, optical read heads, or industrial control transducers can be accurately and easily measured. Delay line allows viewing the leading edge of the triggering signal. By using a composite of Channels 1 and 2 as a trigger source, stable displays of non-time-related signals can be obtained.

Operation from either ac (90 V to 132 V, or 180 V to 264 V, 48 Hz to 440 Hz) or dc (+11 V to +14 V or +22 V to +28 V) assures that power can be obtained at nearly any location.

CHARACTERISTICS

VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

Bandwidth*1

	+20°C to +30°C	−15°C to +55°C
1 mV to 5 mV/div	Dc to 25 MHz	Dc to 20 MHz
10 mV to 5 V/div	Dc to 35 MHz	Dc to 30 MHz
10 V/div	Dc to 25 MHz	Dc to 20 MHz

**1 For ac coupling, the lower 3 dB point is 10 Hz or less with a 1X probe and 1 Hz or less with a 10X probe.*

Deflection Factor — 1 mV/div to 10 V/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated, continuously variable between steps and to at least 25 V/div.

Display Modes — CH 1, CH 2 (normal or inverted), Alternate, Chopped (≈300 kHz rate) added, X-Y.

Input R and C — 1 MΩ ±2%, paralleled by ≈24 pF.

Maximum Input Voltage — Ac or dc coupled, 300 V (dc + peak ac). 300 V p-p ac at 1 kHz or less.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base A — 0.2 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 20 ns/div.

Time Base B — 0.2 μs/div to 50 ms/div (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 20 ns/div.

Variable Time Control — Time Base A provides uncalibrated, continuously variable sweep rates between steps and to at least 1.25 s/div.

Time Base A and B Accuracy*1

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±5%	±6%

**1 Center 8 divisions*

Horizontal Display Modes — A only. A intensified by B, B delayed by A, B triggerable after A.

CALIBRATED SWEEP DELAY

Delay Time Range — Continuously variable from 1 μs to at least 5 s after the start of the delaying (A) sweep.

Differential Time Measurement Accuracy

Delay Time Settings Between 1.0 & 9.0	+15°C to +35°C
One or more major dial divisions	±2%
Less than one major dial division	±0.02%

Jitter — 1 part or less in 20,000 (0.005%) of X10 the A time/div setting.

TRIGGERING A AND B

A Trigger Modes — Normal (sweep runs when triggered); Automatic (sweep free-runs in absence of a triggering signal and for signals below 20 Hz); Single sweep (sweep runs once on the first trigger signal after the reset button is pushed).

Variable Trigger Holdoff — For the A sweep an adjustable holdoff control permits a stable display of complex waveforms. Sweep holdoff time can be increased at least X10.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time). B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once in each of these modes, following the A sweep delay time.

Trigger Sensitivity and Coupling

Coupling	To 10 MHz	At 35 MHz
Dc Internal	0.35 div	1.5 div
Dc External	70 mV	250 mV
Dc Ext ÷ 10	700 mV	2.5 V
Ac	Requirements increase below 60 Hz	
Ac HF Rej	Requirements increase above 20 kHz	
Ac LR Rej	Requirements increase below 40 kHz	

Trigger Sources — Internal CH 1, internal CH 2, internal composite (uses a composite of CH 1 and CH 2 signals to produce trigger), external, external ÷ 10, and line. The B sweep can also be started automatically at the end of the time base A delay.

X-Y OPERATION

Input — X-axis input is via the external horizontal input connection. Both CH 1 and CH 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.

X-Axis Deflection Factors — Variable from ≈20 mV/div to ≈2 V/div. Dc to at least 500 kHz.

Input Impedance — ≈1 MΩ paralleled by 24 pF.

DISPLAY

CRT — 8 x 10 div (0.6 cm/div) display. GH (P31) Phosphor. 12 kV accelerating potential.

Graticule — Internal (nonparallax) nonilluminated. Vertical and horizontal centerlines marked in 5 minor div/major 0.6 cm.

Z-Axis Input — +5 V signal causes noticeable modulation at normal intensity. Useful bandwidth dc to 600 kHz.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −40°C to +75°C.

Altitude — Operating: to 4600 m (15,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5000 ft to 15,000 ft. Nonoperating: to 15 000 m (50,000 ft) maximum.

Vibration — Operating and Nonoperating: 15 minutes along each of the three major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10Hz to 55Hz to 10Hz in 1-minute cycles.

Humidity — 5 cycles (120 hours) referenced to MIL-E-16400 F.

Shock — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.5 V (±1%) ≈1 kHz from 20°C to 30°C.

Power Source — External ac source, 90 V to 132 V or 180 V to 264 V with a line frequency of 48 Hz to 440 Hz. Maximum power dissipation 24 W at 115 V. External dc source: +11 V to +14 V or +22 V to +28 V with a maximum current drain of 2 A at +12 V or 1.0 A at +24V.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width (with handle)	236	9.3
Height	112	4.4
Depth (handle not extended)	347	13.6
Depth (handle extended)	448	17.6
Weight ≈	**kg**	**lb**
Net (without accessories)	4.7	10.5
Shipping	7.6	17.0

INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03); carrying case and pouch (016-0485-00); external dc cable assembly (012-0406-00); strap assembly (346-0131-01); two 1-A fuses (159-0064-00); two 0.4-A fuses (159-0139-00); two 2-A fuses (159-0107-00); three 0.2-A fuses (159-0080-00); service manual; operator's manual.

Order 335 Portable Oscilloscope **$3,135**

The SONY®/TEKTRONIX® 335 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 335 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Viewing Hood — Order 016-0297-00 ..... **$1.40**

CRT Filter — Light blue. Order 378-2016-01 ..... **$1.80**

CRT Filter — Light amber. Order 378-0843-01 ..... **$1.80**

CRT Mesh Filter — With frame and holder. Order 378-0063-00 ..... **$21**

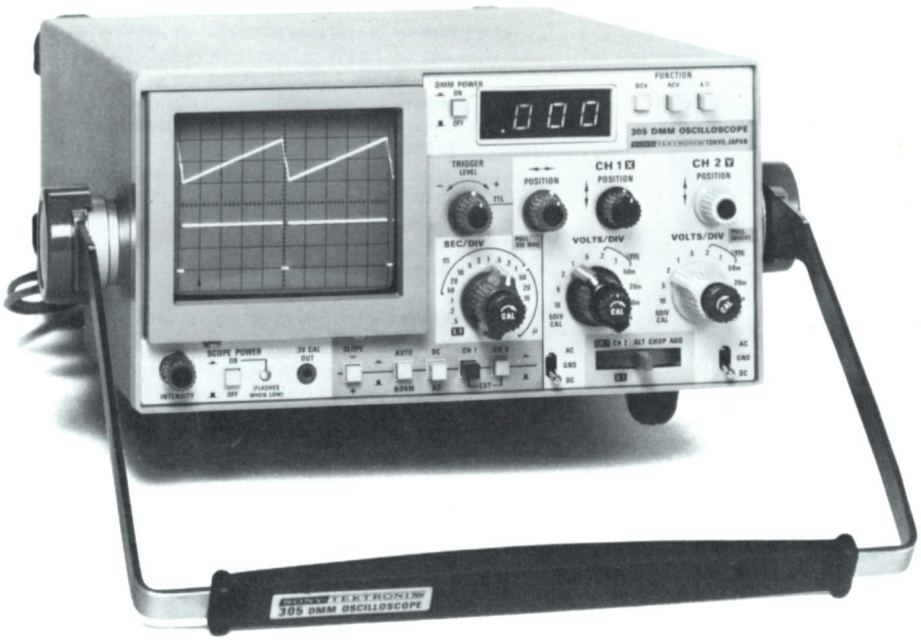
RECOMMENDED CAMERA

C-30BP — General Purpose Camera **$1,375**

Camera Adaptor — Mounts C-30B to 335. Order 016-0327-01 ..... **$170**

For further information see camera section.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.



305

5 MHz at 5 mV/div **Full X-Y**

Dual Trace/DMM **Weighs ≈10.6 lb**

Internal Battery Pack

The 305 Oscilloscope/DMM is the ideal oscilloscope for those who demand portability and multifunction versatility in their test instrumentation.

The SONY®/TEKTRONIX® 305 combines a 5 MHz oscilloscope with an integral autoranging DMM and a built-in rechargeable battery pack. Take the 305 instead of multiple instruments when you climb the ladder to maintain your in-plant industrial controls. Or leave the extension cord at your bench when you go on location to service medical instrumentation.

The 305 features a dual-trace 5 MHz oscilloscope with a large 8 x 10 div (0.6 cm/div) CRT display and an autoranging DMM with dc and ac volts, and resistance measurement functions—all in a 10.6 lb (4.8 kg), 4.4 x 9.3 x 14.6 inch (11.2 x 23.6 x 37.1 cm) package. The front panel TTL marker presets the trigger generator for optimum level control on TTL signals.

CHARACTERISTICS

VERTICAL DEFLECTION

Bandwidth — Dc to at least 5 MHz. For ac coupling, the lower 3 dB point is ≈10 Hz.

Deflection Factor — 5 mV/div to 10 V/div (1-2-5 sequence) accurate ±3% from 0°C to +40°C, ±4% through remainder of operating range. Uncalibrated, continuously variable between steps and to at least 25 V/div.

Display Modes — CH 1, CH 2, Chopped, Alternate, Added, Invert CH 2 and X-Y. Bandwidth in Add mode is dc to at least 4.5 MHz.

Input R & C — 1 MΩ ±2%, paralleled by ≈47 pF.

Maximum Input Voltage — Ac or dc coupled, 250 V (dc + peak ac), or 250 V p-p at <1 kHz.

HORIZONTAL DEFLECTION

Time Base — 500 ms/div to 1 μs/div (1-2-5 sequence). X10 magnifier extends sweep rate to 0.1 μs/div.

Variable Time Control — Uncalibrated, continuously variable between steps and to at least 1.25 s/div.

Time Base Accuracy[*1]

	0°C to +40°C	−15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±5%	±6%

*[*1] Center 8 divisions (excludes first 10 divisions and all sweep past 90 divisions in X10 magnifier).*

TRIGGER

Modes — Normal and Auto (p-p).

TTL Triggering — TTL position of trigger level control presets for optimum triggering from TTL levels, in 50 mV, 0.1 V and 0.2 V/div or external trigger signals.

Trigger Sources — Internal CH 1, internal CH 2, external. TTL Threshold voltage, internal (with 10X probe) 1.4 V within ±0.3 V, External (with 10X probe) 1.4 V within ±0.2 V.

Trigger Sensitivity in Normal Mode

Coupling	To 0.5 MHz	At 5 MHz
Dc Internal	0.3 div	0.75 div
Dc External	15 mV	50 mV
Ac	Requirements increase below 60 Hz	

P-P Auto Operation Sensitivity

Coupling	500 Hz to 0.5 MHz	0.5 MHz to 5 MHz
Dc, Ac Internal	0.5 div	1.0 div
Dc, Ac External	35 mV	70 mV

External Trigger — Maximum Input Voltage: 250 V (dc + peak ac) at 1 kHz or less (same as vertical). Input R and C: ≈1 MΩ paralleled by ≈47 pF.

X-Y OPERATION

Input — X-axis input is via the CH 1 connector; Y-axis input is via the CH 2 connector.

X-Y Characteristics — Same as stated for vertical deflection, except deflection factor accuracy is ±4% from 0°C to +40°C over the center 8 div.

X-Axis Bandwidth — Dc to 150 kHz.

DISPLAY

CRT — 8 x 10 div (0.632 cm/div) display. GH (P31) Phosphor is standard. 2 kV accelerating potential.

Graticule — Internal, nonilluminated.

DMM

DC VOLTAGE

Ranges — 2 V, 20 V, 200 V, 1000 V (autoranging).

Accuracy — Within 0.1% of reading, ±2 counts.

Common-Mode Rejection — >100 dB at dc, 80 dB at 60 Hz with 1 kΩ imbalance.

Normal-Mode Rejection — >30 dB at 60 Hz increasing 20 dB per decade to 2 kHz.

Response — <1 s plus range step time (<1 s/step).

Input R — 10 MΩ ±2%.

Maximum Input Voltage — ±1000 V (dc + peak ac) between HI and LO inputs or between HI and chassis. ±500 (dc + peak ac) between LO and chassis (LO Floating Voltage).

AC VOLTAGE

Ranges — 2 V, 20 V, 200 V, 700 V, (autoranging).

Accuracy — Within 0.5% of reading, ±10 counts, 40 Hz to 500 Hz.

Response Time — <5 s plus range step time (<1 s/step).

Input Impedance — 10 MΩ paralled by ≈70 pF.

Maximum Input Voltage — 700 V RMS if sinusoidal. ±1000 V (dc + peak ac) between HI and LO inputs or between HI and chassis. ±500 V (dc component) between HI and LO inputs.
±500 (dc + peak ac) between LO and chassis (LO Floating Voltage).

RESISTANCE

Ranges — 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ.

Accuracy — Within 0.6% of reading ±3 counts.

Response Time — <5 s plus range step time (<1 s/step).

Maximum Input Voltage — ±100 V (dc + peak ac) between HI and LO inputs. 500 V (dc + peak ac) between LO and chassis (LO Floating Voltage).

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating: −15°C to +55°C (Oscilloscope), 0°C to +55°C (DMM). Nonoperating: −25°C to +75°C.

Altitude — Operating: To 9000 m (30,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5,000 ft to 30,000 ft. Nonoperating: To 15 000 m (50,000 ft) maximum.

Vibration — 15 minutes along each of the 3 major axes, 0.025 in (0.06 cm) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

Humidity — Nonoperating: 5 cycles (120 hours) of MIL-E-16400G. Omit freezing and vibration and allow a post-test drying period at +25°C, ±5°C and 20% to 80% relative humidity.

Shock — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration. Total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.3 V accurate ±1% from 20°C to 30°C ±2% from −15°C to +55°C.

Power Sources — External ac source, 90 V to 132 V or 180 V to 250 V with a line frequency of 48 Hz to 440 Hz. Maximum power dissipation of 17 W. External dc source +9 V to +32 V.

Charge Time — At least 16 hours for full charge.

Operating Time — Internal NiCd batteries provide ≈1.6 hours of scope and DMM operation, 10 hours of DMM alone operation, or two hours of scope alone operation at maximum trace intensity and 20°C to 25°C operating temperature.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width (with handle)	236	9.3
Height	112	4.4
Depth (handle not extended)	371	14.6
Depth (handled extended)	458	18.0
Weights ≈	**kg**	**lb**
Net (without accessories)	4.8	10.6
Shipping	7.8	17.1

INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03); carrying case (016-0401-00); carrying case cover (200-2260-00); carrying strap assembly (346-0131-01); DMM probe package (012-0732-00); clear CRT filter (331-0394-01); blue CRT filter (378-2016-01); external dc cable assembly (012-0406-00); service manual; operator's manual.

Order 305 DMM/Oscilloscope **$2,405**

The SONY®/TEKTRONIX® 305 DMM/Oscilloscope is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 305 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Viewing Hood — Order 016-0297-00 ..... **$1.40**

Adaptor Connector — BNC to binding post.
Order 103-0033-00 ..... **$4.75**

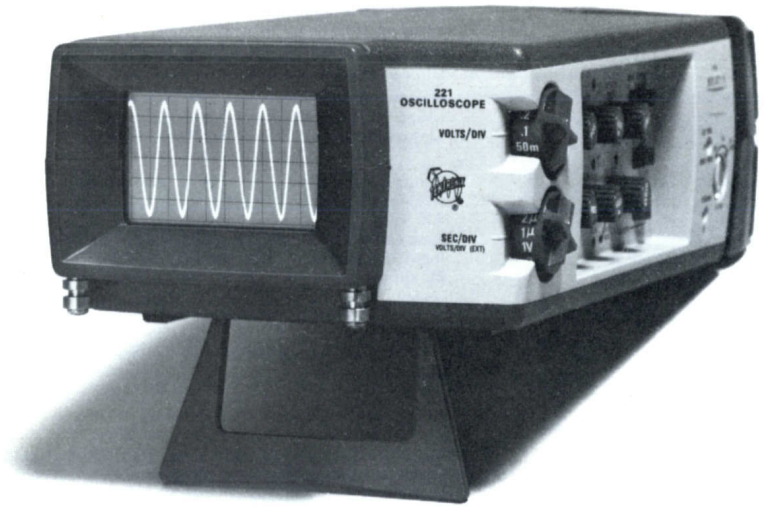
RECOMMENDED CAMERA

C-30BP — General purpose camera.
Order C-30BP **$1,375**

Camera Adaptor Mounts — C-30B to 305.
Order 016-0327-01 ..... **$170**

For further information see camera section.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.



221

5 MHz, 5 mV/div to 100 V/div

0.1 μs/div Sweep Rate with X10 Sweep Magnifier

Internal Battery Pack

Integral 1 MΩ Probe

Weighs ≈1.6 kg (3.5 lb)

The 221 Miniscope weighs just 3.5 pounds and measures only 3 x 5.2 x 9 inches. It easily fits into a tool box or brief case, yet has the capability needed for on-site service of much of today's complex equipment. This versatile miniscope has a 5 MHz bandwidth, 5 mV/div sensitivity, and 0.1 μs/div sweep rate (using X10 magnifier) packaged in an impact-resistant case.

Internal rechargeable batteries allow at least two hours operation away from external power sources. And the 221 will operate and charge from practically all the world's principal line voltages: 90 V to 250 V, 48 Hz to 62 Hz ac, or 80 V to 250 V dc (all without making any change to the instrument).

The 1 MΩ low-capacitance probe minimizes circuit loading. And because it's attached, it's always there when you need it. Vertical deflection factors extend from 5 mV/div, allowing on-screen measurement of signals up to 600 V dc + peak ac. The 1 μs/div to 200 ms/div time base is enhanced by a X10 magnifier that extends the fastest range to 0.1 μs/div. A variable control will slow the sweep to about 0.5 s/div.

A single rotary control on the 221 is used for all trigger level and slope functions. Controls are side mounted and recessed for protection, yet are easily accessible.

In applications where it is necessary to "float" the oscilloscope to make your measurements, 200 Series miniscopes can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, caution should be observed when connecting the probe to test points.

The 221 is used in a wide assortment of service applications. For example, in data transmission systems, the 221 is preferred for maintenance and testing of modems because of its ability to see higher frequency noise. It can even help in building roads by spot checking motors in a road grader's closed loop servo system that controls blade angle, depth of cut and machine direction.

CHARACTERISTICS

VERTICAL DEFLECTION

Bandwidth — Dc to 5 MHz (−3 dB point) at all calibrated deflection factors. Lower −3 dB point ac coupled is ≈2 Hz.

Deflection Factor — 5 mV/div to 100 V/div, accurate ±3% from 0°C to +40°C and ±5% from −15°C to 0°C and +40°C to +55°C. Uncalibrated, continuously variable between steps to at least 300 V/div.

Input R and C — ≈1 MΩ paralleled by ≈29 pF via attached signal acquisition probe.

Maximum Input Voltage — 600 V (dc + peak ac), 600 V p-p ac, 5 MHz or less.

HORIZONTAL DEFLECTION

Time Base — 1 μs/div to 200 ms/div, accurate ±3%.

Magnifier — Increases all sweep speeds X10 with a maximum sweep speed of 0.1 μs/div.

Variable Time Control — Extends minimum sweep rate to ≈0.5 s/div. Continuously variable between calibrated settings.

TRIGGER

Modes — Automatic or manual. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Trigger Sensitivity

Source	To 1 MHz	At 5 MHz
Internal	0.5 div	1 div
External	0.5 V	1 V

X-Y OPERATION

Input — X-axis input is via the external trigger or the external horizontal input.

X-Axis Deflection Factor — 1 V/div ±10%, dc to 500 kHz. Sensitivity is increased by a factor of 10 (0.1 V/div) using horizontal magnifier.

Maximum External Horizontal Input Voltage — 200 (dc + peak ac), 200 V (p-p ac) to 500 kHz, decreasing to 20 V p-p ac at 5 MHz.

Input Impedance — ≈0.5 MΩ paralleled by ≈30 pF.

DISPLAY

CRT — 6 x 10 div (0.52 cm/div) display. GH (P31) Phosphor normally supplied. 1 kV accelerating potential.

Graticule — Internal, black line, nonilluminated.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating (Battery Only): −15°C to +55°C. Charging or Operating from Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: 7600 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

Humidity — 5 days at +50°C, 95% humidity.

Shock — Operating and Nonoperating: 100 g's, ½ sine, 2 ms duration each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Power Sources — Internal NiCd batteries provide at least 2 hours operation at maximum trace intensity for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended time charges will not damage the batteries. An expanded scale battery meter indicates full, low, and recharge. External power source, 90 V to 250 V ac (48 Hz to 62 Hz) or 80 V to 250 V dc, 5 W or less.

Insulation Voltage — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord stored and the plug protected. When operated from an external line, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4 x line + (dc + peak ac) not to exceed 350 V.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	133	5.2
Height	76	3.0
Depth	228	9.0
Weights ≈	**kg**	**lb**
Net (w/o accesssories)	1.6	3.5
Shipping	3.6	8.0

INCLUDED ACCESSORIES

Viewing hood (016-0199-01); carrying case (016-0512-00); neck strap (346-0104-00); two spare fuses (159-0080-00); service manual; operator's manual.

Order 221 Oscilloscope, (Includes Batteries and Probe) **$1,910**

OPTIONAL ACCESSORIES

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ inch) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor (103-0051-01).
Order 015-0231-00 ..... **$20**

Probe-Tip — To BNC Panel Connector Adaptor.
Order 013-0084-01 ..... **$8.00**

Probe-Tip — To BNC Cable Adaptor.
Order 103-0096-00 ..... **$11**

Power Cable Adaptor Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 ..... **$7.00**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

213

1 MHz at 20 mV/div

0.4 µs/div Sweep Rate with X10 Sweep Magnifier

DMM and Miniscope in One Unit

Rugged Construction

Internal Battery

Compact, Weighs ≈1.7 kg (3.7 lb)

True RMS Voltage & Current Measurements

The 213 combines a precision 3½ digit digital multimeter and a 1 MHz oscilloscope in one instrument. It is a compact (3 x 5.2 x 8.9 inches) and light weight (only 3.7 pounds) package that will fit easily into your briefcase or tool kit.

In operation, the light weight 213 can be hand held, rested on the equipment being tested or carried conveniently on a neck-strap. Operating controls are designed for speedy measurements and easy understanding.

Rugged construction enables the 213 to withstand hostile industrial or transportation environments.

The 213, combining both oscilloscope and DMM functions, fits many on-site service applications. As an example, the 213 is used extensively for preventive maintenance on industrial control systems.

CHARACTERISTICS

VERTICAL DEFLECTION (VOLTAGE)

Bandwidth — Dc to 1 MHz (−3 dB point) for 20 mV/div to 100 V/div deflection factors. Dc to 400 kHz (−3 dB point) for 5 mV/div and 10 mV/div. Lower −3 dB point for ac coupling is ≈1 Hz.

Deflection Factor — 5 mV/div to 100 V/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps to at least 250 V/div.

Input R and C — 10 MΩ paralleled by 150 pF for 5 mV/div through 1 V/div and 100 pF for 2 V/div through 100 V/div.

Maximum Input Voltage

Input Condition	Maximum Input Voltage
Dc coupled, 5 mV/div to 1 V/div	500 V (dc + peak ac) at 1 MHz or less
Ac coupled, 5 mV/div to 1 V/div	800 V (dc + peak ac) 500 V peak ac component
Ac, Dc coupled, 2 V/div to 100 V/div	800 V (dc + peak ac) at 1 MHz or less

VERTICAL DEFLECTION (CURRENT)

Bandwidth — Dc to at least 400 kHz (−3 dB point) for 20 µA/div through 100 mA/div deflection factors. Dc to at least 200 kHz (−3 dB point) for 5 µA/div and 10 µA/div.

Deflection Factor — 5 µA/div to 100 mA/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps to at least 250 mA/div.

Maximum Input Current — 2 A RMS or 3 A peak for any range (fuse and diode protection).

HORIZONTAL DEFLECTION

Time Base — 2 µs/div to 500 ms/div (1-2-5 sequence). Accuracy: ±5%.

Variable Magnifier — Increases all sweep speeds to at least X5 with a maximum sweep speed of 0.4 µs/div.

TRIGGER

Modes — Normal (sweep runs when triggered). Automatic (sweep free-runs in absence of trigger signal or for frequencies below 7 Hz).

Trigger Sensitivity and Coupling — Ac Internal: (Auto and Normal 1 MHz) 0.5 div. Dc External: 1 MHz, 1 V.

DISPLAY

CRT — 6 x 10 div (0.52 cm/div) display. GY (P43) Phosphor.

Graticule — Internal, black line, nonilluminated.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating (Battery Only): −15°C to +55°C. Charging or Operating from Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: To 7500 m (25,000 ft), decrease maximum temperature by 1°C/1,000 ft above 15,000 ft. Nonoperating: 12 500 m (40,000 ft).

Vibration — Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

Humidity — +40°C or less, 80% or less relative humidity.

Shock — Operating and Nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Power Sources — Internal NiCd batteries provide three to five hours operation at maximum trace intensity for a charging and operating temperature between +20°C and +30°C. Internal charger charges batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops below 2 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. External power source, 90 V to 136 V ac (48 Hz to 62 Hz). Option 01 allows operation from an external 180 V to 250 V ac (48 Hz to 62 Hz) or dc supply. Power consumption, 8 W or less.

Insulation Voltage — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries with line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS or 1.4X line + (dc + peak ac) not to exceed 350 V.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	133	5.2
Height	76	3.0
Depth	226	8.9
Weights ≈	**kg**	**lb**
Net (without accessories)	1.7	3.7
Shipping	3.9	8.6

DMM

Provides true RMS readings of voltage and current.

DC AND AC VOLTAGE

Range — 0.1 V to 1000 V full scale in five ranges.

Resolution — 100 µV at 0.1 V full scale.

Accuracy in Dc Mode — For +25°C ±5°C.

Range[*1]

0.1 V	±0.1% of reading ±3 counts. Temp coef is (±0.015% of reading +0.04% of full scale) per °C
1 V	±0.1% of reading ±1 count. Temp coef is (±0.01% of reading +0.01% of full scale) per °C
10 V and 100 V	±0.15% of reading ±1 count. Temp coef is (±0.015% of reading +0.01% of full scale) per °C
1000 V	±0.2% of reading ±1 count. Temp coef is (±0.02% of reading +0.01% of full scale) per °C

*[*1] Full scale*

Accuracy in RMS Mode — For 25°C ±5°. Temperature coefficient (±0.05% of reading +0.1% of full scale) per °C.

Range	Within % of reading shown ±5 counts[*1]		
	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz
0.1 V	2.5%	1.5%	3.5%
1 V,10 V, & 100 V	2%	1%	1%
1000 V	2%	1%	2%

*[*1] Accuracy limit increases linearly for crest factor >2 up to twice indicated limit for crest factor of five.*

Input Resistance — 10 MΩ.

Input Capacitance — 150 pF on 0.1 V to 10 V ranges, 100 pF on 100 V and 1000 V ranges.

Settling Time — Dc: 1.5 s to 0.1% of reading. RMS: 2 s to 1% of reading.

Maximum Input Voltage

Range	Dc Coupled	Ac Coupled
0.1 V to 10 V	500 V[*1]	800 V[*1]
100 V to 1000 V	800 V[*1]	

*[*1] Dc + peak ac*

DC AND AC CURRENT

Range — 0.1 mA to 1000 mA full scale in five ranges.

Resolution — 100 nA at 0.1 mA full scale.

Accuracy in Dc Mode — For +25°C ±5°C.

Temperature Coef — (±0.02% of reading ±0.04% of full scale) per °C. 0.1 mA ±0.5% ±3 counts. 1 mA to 1000 mA ±0.25% ±3 counts.

Accuracy in Ac Mode

Range	Within % of reading shown ±5 counts[*1]		
	Dc	40 Hz to 4 kHz	4 kHz to40 kHz
0.1 mA	2.5%	1.5%	4.5%
1 mA to 1000 mA	2.5%	1.5%	3.5%

*[*1] Accuracy limit increases linearly for crest factor >2 up to twice the indicated limit for crest factor of five.*

Settling Time — 1.5 s to 0.1% of reading.

Maximum Input Current — 2 A RMS or 3 A peak on any scale (fuse and diode protection).

RESISTANCE

Ranges — 1 kΩ to 10 MΩ full scale in five ranges.

Resolution — 1 Ω on 1 kΩ scale.

Accuracy — For 25°C ±5°C.

Range	% of Reading
1 kΩ	0.5% ±3 counts
10 kΩ to 1 MΩ	0.5% ±1 count
10 MΩ	1% ±1 count

Settling Time — Two seconds ±2 counts.

READOUT

Number of Digits — 3½ digits plus decimal point and sign.

Display Size — 1 cm high by 4 cm wide (five characters).

Over-Range Capability — At least 200% of full scale.

Over-Range Indication — Displays scrambled characters.

INCLUDED ACCESSORIES

Viewing hood (016-0199-01); carrying case (016-0512-00); two alligator clip to banana jack test leads (red 012-0015-00, black 012-0014-00); neck strap (346-0104-00); two power line fuses (159-0080-00); identification tag (334-2614-00); identification tag (000-7983-00); Option 01 power line plug adaptor (161-0077-01); service manual; operator's manual.

ORDERING INFORMATION

213 Miniscope/DMM

(Includes Batteries and Probe) **$2,510**

Option 01 — 180 to 250 V ac (48 to 62 Hz) or dc (includes batteries and probe) ..... **NC**

OPTIONAL ACCESSORIES

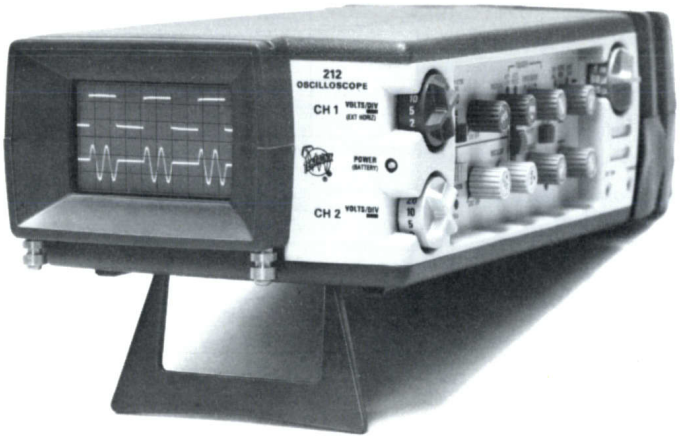
Alligator Clip Kit — A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ in) conductor. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor (103-0051-01).
Order 015-0231-00 ..... **$20**

Probe-Tip — To BNC Panel Connector Adaptor.
Order 013-0084-01 ..... **$8.00**

Probe Tip — To BNC Cable Adaptor.
Order 103-0096-00 ..... **$11**

Power Cable Adaptor Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.
Order 161-0077-01 ..... **$7.00**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.



212

500 kHz, 1 mV/div to 50 V/div

Internal Battery

Integral 1 MΩ Probe

Weighs ≈1.6 kg (3.5 lb)

The 212 features these signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is light weight (only 3.5 pounds) and compact (3 x 5.25 x 9.5 inches).

Built of impact-resistant plastic and fully self-contained, this miniature portable is perfect for applications in severe environments. And it permits "floating" measurements since it is double insulated and can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 212 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument—you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

CHARACTERISTICS

VERTICAL DEFLECTION

Bandwidth — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower −3 dB point ac coupled is <2 Hz.

Deflection Factors — 1 mV/div to 50 V/div (1-2-5 sequence). Accuracy: ±5%. Uncalibrated: Continuously variable between steps to at least 125 V/div.

Display Modes — CH 1 only, CH 2 only, or CH 1 and CH 2 Chopped (chop rate ≈50 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

Input R and C — ≈1 MΩ paralleled by ≈160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

Maximum Input Voltage[*1]

1 mV/div to 50 mV/div	600 V (dc + peak ac) ac not over 2 kHz.
0.1 V/div to 50 V/div	600 V (dc + peak ac) 600 V p-p ac 5 MHz or less

*[*1] 1X probe only*

HORIZONTAL DEFLECTION

Time Base — 5 μs/div to 500 ms/div, accurate ±5%.

Variable Magnifier — Increases each sweep rate X5 with a maximum sweep speed of 1 μs/div.

External Horizontal Input — (CH 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz <3°. Input characteristics same as CH 1.

Maximum External Horizontal Input Voltage and Impedance — Same as for vertical inputs.

TRIGGER

Modes — Automatic or normal. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Trigger Sensitivity and Coupling

Dc Coupling	To 500 Hz
Internal (w/composite trigger source)	0.2 div
Internal (w/CH 2 trigger source)	0.2 div
External	1 V

Maximum External Trigger Input Voltage — 8 V (dc + peak ac), 16 V (p-p ac) at 1 MHz or less.

Input Impedance — R and C, 1 MΩ paralleled by ≈30 pF.

DISPLAY

CRT — 6 x 10 div (0.52 cm/div) display. GH (P31) Phosphor is standard.

Graticule — Internal, black line, nonilluminated.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating (Battery Only): −15°C to +55°C. Charging or Operating from Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: 7500 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating and Nonoperating: 15 minutes along each of the three major axes. 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

Humidity — Five cycles (120 hours). 95% Relative Humidity, referenced to MIL-E-16400F.

Shock — Operating and Nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Power Sources — Internal NiCd batteries provide ≈ three to five hours operation for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned off. Battery operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about ten minutes of operating time remaining in the batteries.

External Ac Source — 110 V to 126 V, 58 Hz to 62 Hz, 3 W. Can be operated at 104 V to 110 V with resulting slow discharge of internal batteries.

Insulation Voltage — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4X line + (dc + peak ac) not to exceed 350 V.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	133	5.3
Height	76	3.0
Depth	241	9.5
Weights ≈	**kg**	**lb**
Net (without accessories)	1.6	3.5
Shipping	3.2	7.0

INCLUDED ACCESSORIES

Viewing hood (016-0199-01); carrying case (016-0512-00); two 4-A fuses (159-0121-00); identification tags (000-7983-00); identification tag (334-2614-00); carrying strap (346-0104-00); service ; operator's manual.

ORDERING INFORMATION

212 Dual-Trace Oscilloscope
(Includes Batteries and Probes **$1,775**

POWER OPTIONS

Option 01 — For 220 V to 250 V (48 Hz to 52 Hz). Includes Batteries ..... **NC**

Option 02 — For 90 V to 110 V (48 Hz to 52 Hz). Includes Batteries ..... **NC**

OPTIONAL ACCESSORIES

10X Attenuator Package — A slip-on tip to provide lower circuit loading (4.4 MΩ, ≈20 pF) and higher maximum input voltage 1000 V (dc + peak ac) includes: 10X attenuator (010-0378-01); pincher tip (013-0071-00); flex tip (206-0060-00); banana tip (134-0013-00); IC adaptor (206-0203-00). Order 010-0378-01 ..... **$47**

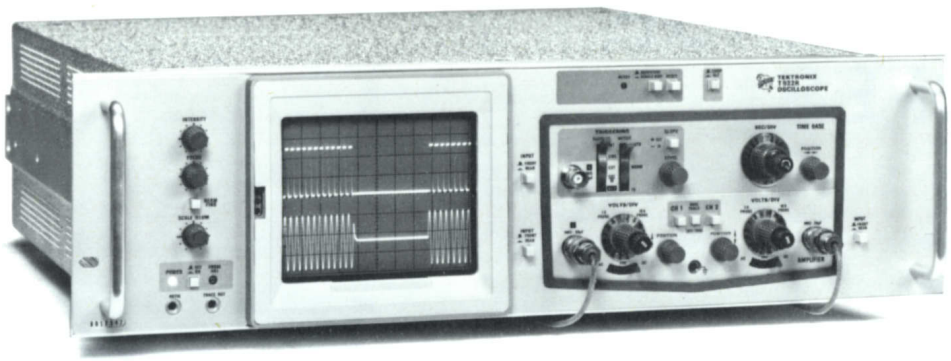
Alligator Clip Kit — A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large ⅜ in) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor 103-0051-01).
Order 015-0231-00 ..... **$20**

Probe-Tip — To BNC Panel Connector Adaptor.
Order 013-0084-01 ..... **$8.00**

Probe-Tip — To BNC Cable Adaptor.
Order 103-0096-00 ..... **$11**

Power Cable Adaptor Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 ..... **$7.00**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.



T922R

Dc to 15 MHz at 2 mV/div

Switchable Front and Rear Signal Inputs

Only 13.3 x 48.2 x 43.2 cm, 9.1 kg (5.25 x 19 x 17 in, 20 lb)

Single Sweep Operation

Bright (12 kV) Display

The T922R is a rackmount multipurpose 15 MHz oscilloscope. It features: 15 MHz bandwidth at 2 mV/div vertical sensitivity, 20 ns/div maximum sweep rate with the X10 magnification control, switchable front and rear signal inputs, selectable chop and alternate sweeps, graticule illumination and rear panel outputs (gate out, sweep out and vertical signal out). The T922R fits any standard 48 cm (19 in) rack and weighs only 9.1 kg (20 lb). Option 01 adds the differential capability.

Many companies are using the T922R for their production testing applications—often as an inexpensive replacement for aging instruments which require frequent repair and calibration.

CHARACTERISTICS

Seven recessed rear panel BNC connectors provide: CH 1, CH 2 vertical signal input, external trigger input, Z-axis input, sweep output, gate output, vertical output.

VERTICAL SYSTEM

Mode Selections — CH 1: Displays only the CH 1 signal. CH 2: Displays only the CH 2 signal. Dual Trace: Displays CH 1 and CH 2 signals simultaneously. Alternate or Chopped mode is manually selectable.

Deflection Factor — Range: 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence.

Accuracy

+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

Uncalibrated Range (VAR) — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

Frequency Response — Dc to at least 15 MHz (measured at −3 dB).

Risetime — 23 ns or less.

Chopped Mode Repetition Rate (Dual Trace) — ≈250 kHz.

Input Resistance — ≈1 MΩ.

Input Capacitance — 30 pF.

Maximum Input Voltage — Dc Coupled: 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less, Ac Coupled: 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Delay Line — Permits viewing edge of displayed waveform.

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.2 μs/div in 20 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends maximum sweep rate to 20 ns/div.

Accuracy

	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +40°C	Within 4%	Within 6%

TRIGGER

Trigger Modes — Auto: Permits normal triggering on waveforms with a repetition rate of at least 20 Hz. Sweep "free runs" in the absence of an adequate trigger signal, or with a repetition rate below 20 Hz. Normal: Permits normal triggering. Sweep does not run In the absence of an adequate trigger signal. TV: Provides triggering on TV field when Sec/Div switch is set at 0.1 ms or slower, Trigger on TV line when Sec/Div switch is set at 50 μs or faster. Slope + Out − In: Sweep is triggered on the positive/negative-going slope of the triggering waveform. Level: Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Triggering Sensitivity — Auto and Normal: 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 15 MHz. TV: Composite sync 1 div internal or 100 mV external (about 2.3 div or 230 mV of composite video).

External Trigger Input — Maximum Input: 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less. Input Resistance: ≈1 MΩ. Input Capacitance: 30 pF.

X-Y OPERATION

Sensitivity (Variable Magnifier) — From ≈100 mV/div (X10 mag) to ≈1 V/div (X1 mag) for X; Y is adjusted by vertical control.

X-Axis Bandwidth — Dc to at least 1 MHz (measured at −3 dB).

Input Resistance — ≈1 MΩ.

Input Capacitance — 30 pF.

Phase Difference Between X-Axis and Y-Axis Amplifiers — Within 5° from dc to 50 kHz.

CRT DISPLAY

Display Area — 8 x 10 cm illuminated internal graticule.

Standard Phosphor — GH (P31) is standard.

Beam Finder — Locates off-screen display.

Nominal Accelerating Potential — ≈12 kV.

Z-Axis Input — 5 V signal causes noticeable intensity modulation. Polarity of the voltage causing a decrease in intensity is internally selectable.

PROBE ADJUST

Output Voltage — ≈0.5 V.

Repetition Rate — ≈1 kHz.

OUTPUTS

Sweep/Gate Out — Output Voltage is: ≈5 V. Positive going into 1 MΩ: ≈50 mV into 50 Ω load.

Vertical Output — A composite of CH 1 and CH 2 with ≈0.5 V output per displayed division into a 1 MΩ load. ≈50 mV with 50 Ω load. Bandwidth is at least 1 MHz.

AC POWER REQUIREMENTS

Line Voltage Ranges — 100 V to 120 V, 220 V to 240 V line voltage and HI/LO range are accessible externally.

100 V to 120 V Range — HI: 108 V to 132 V RMS. LO: 90 V to 110 V RMS.

220 V to 240 V Range — HI: 216 V to 250 V RMS. LO: 198 V to 242 V RMS.

Line Frequency — 50 Hz to 60 Hz.

Power Consumption — 50 W (maximum), 0.35 A (maximum) at 120 V, 60 Hz.

Canadian Standards Association Certified.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	132	5.2
Depth	432	17.0
Weight	**kg**	**lb**
Net	9.1	20.0
Shipping	15.0	33.0

ENVIRONMENTAL CAPABILITIES

Temperature — Nonoperating: −55°C to +75°C. Operating: 0°C to +45°C.

Altitude — Nonoperating: To 15 000 m; (50,000 ft). Operating: To 4600 m; (15,000 ft) maximum. Operating temperature decreased 1°C/304.8 meters (1,000 ft) above 1524 m (5,000 ft).

CAMERAS

T922R interfaces to all Tektronix Cameras.

INCLUDED ACCESSORIES

Clear implosion shield (337-2185-03); service manual; operator's manual.

ORDERING INFORMATION

T922R — Rackmount Oscilloscope **$995**

Option 01 — Differential Input ..... **+$110**

OPTIONAL ACCESSORIES

Rackmount Hardware Kit
Order 016-0375-00 ..... **$90**

Viewing Hood — Provides for convenient viewing in high ambient light conditions. Order 016-0154-00 ..... **$28**

P6122 — 10X Passive Probe
Order 010-6122-01 ..... **$77**

C-5C Camera

Recommended for all T900 Series oscilloscopes, the C-5C attaches directly to the front panel without adaptors and uses Polaroid pack film. A fixed f/16 lens aperture, an electric shutter with timed speeds from 0.1 to five seconds, plus open shutter mode, and bulb, combine to make the C-5C Option 03 which includes a built-in Xenon flash unit that flashes to illuminate the graticule when the shutter opens. The T922R uses the C-5C Option 01, without the Xenon flash. Batteries are not included for either version.

Order C-5C, Option 03 ..... **$530**
C-5C, Option 01 ..... **$510**

An NTSC IRE TV graticule is available. Ask your local Tek Sales Engineer or Representative.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

NEW

PORTABLE STORAGE OSCILLOSCOPES

GPIB IEEE-488

468/R468

The 468 and R468 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

10 MHz Useful Storage Bandwidth

Cursors for Time and Voltage Measurements

Signal Averaging

Envelope Mode (Patented)

GPIB Option

100 MHz Nonstorage Bandwidth

Advancing the state-of-the-art in digital storage oscilloscopes is the Tektronix 468. This high performance portable scope is capable of accurately storing and displaying 10 MHz single shot events using a unique display interpolation system.

The 468 was designed with many features which enhance its usefulness in your applications. Cursors and a calibrated LED readout enable you to measure time or voltage differences easily and accurately.

Signal Averaging, now standard on the 468, can be used to remove random noise from a signal and improve measurement accuracy.

Option 02 provides a GPIB interface (talk only). This transmits stored waveforms and scale factor information to a listener or controller.

See page 350 for complete description and specifications of the 468.

GPIB IEEE-488

NEW 336

The 336 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

1 MS/s, 140 kHz Useful Storage Bandwidth

Cursors for Time and Voltage Measurements

Signal Averaging

Envelope Mode

GPIB and 8 Screen Memory Option (16 k)

50 MHz Nonstorage Bandwidth

CRT Readout

The SONY/TEKTRONIX 336 is a combination nonstorage and digital storage portable oscilloscope. It is capable of displaying analog and digitized waveforms simultaneously, and can store up to 18 digitized waveforms for recall and display. The 336 is a microprocessor controlled instrument that incorporates alphanumeric CRT readouts of the vertical and horizontal scale factors, the delay time position, and voltage and time readouts of the cursor positions. Many of the oscilloscope features and modes are chosen from a menu displayed on the CRT rather than from hard-wired front-panel switches. Also included is an Auto mode for both vertical volts per division and horizontal time per division, allowing "hands off" operation in many applications.

Option 01 provides the additional signal transmission capability of a GPIB talker only interface and added storage space for up to 18 waveforms total storage capability in View memory. A backup battery with Option 01 maintains the stored waveform data and front panel settings while the instrument is off for periods of at least three days (after the battery is charged during operation of the 336).

See page 352 for complete description and specifications of the 336.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

466/464

100 MHz at 5 mV/div

5 ns/div Sweep Rate with X10 Sweep Magnifier

Variable Persistence and Fast Mesh Transfer Storage Modes

3000 div/μs Stored Writing Speed (466)

Battery Operation (Optional)

Third Channel Trigger View

Weighs ≈11.8 kg (26 lb)

The 466 and 464 Portable Storage Oscilloscopes are both designed to display nonrepetitive or slow moving signals. And with the exception of increased stored writing speed on the 466, both instruments offer similar performance.

Operating in a reduced scan mode, the stored writing speed of the 466 is 3000 div/μs (1350 cm/μs). The lower cost 464 doesn't offer a reduced scan mode and stores at 110 div/μs. Both instruments feature two modes of storage — variable persistence and fast transfer.

The bright 8 x 10 div CRT on both instruments comprises 0.90 cm/divisions. In the 466, reduced scan graticule is superimposed over the center of the main graticule, measuring 8 x 10 divisions with 0.45 cm/division. All graticules are etched onto the inner face of the CRT to eliminate parallax problems. A third channel trigger view is included for the 466 and 464. This allows the simultaneous display of channels 1 and 2 with the external A trigger.

Tektronix P6062B Probes provide operator convenience of 1X or 10X input attenuation at the probe tip. The correct deflection factor is automatically indicated on the 464 or 466 front panel when the probe attenuation factor is switched.

Light weight plus the ability to use optional, external dc power makes both the 466 and 464 sufficiently portable for virtually all field measurement applications. The snap-on 1106 Battery Pack is also useful in isolating these oscilloscopes from noisy or intermittent power sources.

466 DMM with Differential Time DMM Option

CHARACTERISTICS

All characteristics apply to both the 466 and 464, except where indicated.

VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

Bandwidth*[1] and Risetime — At all deflection factors from 50 Ω terminated source.

−15°C to +40°C	+40°C to +55°C
Dc to 100 MHz, ≤3.5 ns	Dc to 85 MHz, ≤4.15 ns

[1] Measured at −3 dB down. Bandwidth may be limited to ≈20 MHz by bandwidth limit switch. Lower −3 dB point, ac coupling 1X probe; 10 Hz or less. 10X probe; 1 Hz or less.

Deflection Factor — 5 mV/div to 5 V/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps and to ≈12.5 V/div. In cascade mode sensitivity is ≈1 mV/div. Cascaded bandwith is at least 50 MHz when signal out is terminated in 50 Ω.

Display Modes — CH 1, CH 2 (normal or inverted), alternate, chopped (≈250 kHz), added, X-Y.

Common-Mode Rejection Ratio — At least 20 dB at 20 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2% paralled by ≈20 pF.

Maximum Input Voltage

Dc Coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac Coupled	500 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base A — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnifier extends sweep rate to 5 ns/div.

Time Base B — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 mag extends sweep rate to 5 ns/div.

Variable Time Control — Time Base A: Provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A and B Accuracy.*[1]

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

[1] Full 10 divisions.

Horizontal Display Modes — A, mixed sweep, A intensified, B delayed. B ends A for increased intensity in the delayed mode.

Calibrated Mixed Sweep — Displays A sweep for period determined by Delay-Time Position control, then displays B sweep for remainder of horizontal sweep.

CALIBRATED SWEEP DELAY

Delay Time Range — 0.2 to X10 delay time/div settings of 200 ns to 0.5 s (minimum delay time is 200 ns).

Differential Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C	−15°C to +55°C
Over one or more major dial div	±1%	±2.5%
Less than one major dial div	±0.01 major dial div	±0.025 major dial div

Jitter — One part or less in 50,000 (0.002%) of X10 the A sweep time/div setting.

TRIGGER

A Trigger Modes — Normal (sweep runs when triggered), automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive complex waveforms. At least 10:1 variation.

B Trigger Modes — B starts after delay time (starts automatically at the end of the delay time). B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity and Coupling

Coupling	To 25 MHz	At 100 MHz
Dc Internal	0.3 div deflection	1.5 div deflection
Dc External	50 mV	150 mV
Dc External ÷ 10	500 mV	1.5 V
Ac	Requirements increase below 60 Hz	
Ac LF Reject	Requirements increase below 50 kHz	
Ac HF Reject	Requirements increase below 30 Hz and above 50 kHz	

Jitter — 0.5 ns or less at 100 MHz and 5 ns/div (X10 magnifier).

A Trigger View — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is ≈50 mV/div (0.5 V/div with external ÷ 10 source).

Level and Slope — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷ 10.

A Sources — Normal, CH 1, CH 2 line, external and external ÷ 10.

B Sources — Starts after delay, normal, CH 1, CH 2, and external.

External Inputs — R and C ≈1 MΩ paralleled by ≈20 pF. 250 V (dc + peak ac) maximum input.

Third Channel Trigger View — Deflection Factor (Dc Trigger Coupling Only). Ext is: 100 mV/div ±5%. Ext ÷ 10 is: 1 V/div ±5%. Delay Difference: 5.0 ±0.5 ns after vertical display. Trigger Point: ≈ center screen. Risetime: ≤5 ns. Aberration: <10% p-p.

X-Y OPERATION

Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical) — 5 mV/div to 5 V/div. Accuracy: ±4%. Bandwidth: Dc to at least 4 MHz. Phase Difference Between Amplifiers: 3° or less from dc to 50 kHz.

DISPLAY

CRT — 8 x 10 div display, each div is 0.9 cm (normal); 0.45 cm/div reduced scan (466 only). 8.5 kV accelerating potential, normal-mode, 10 kV reduced scan (466 only). GH (P31) Phosphor is standard.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an off-screen signal. A preset intensity level provides a constant brightness.

Z-Axis Input — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

STORED WRITING SPEEDS

Full Scan*1	466	464	Storage*2 View Time
Fast Transfer	150 div/μs	110 div/μs	>15s
Variable Persistance	0.5 div/μs	0.5 div/μs	>15s
Reduced Scan*3			
Fast Transfer	3,000 div/μs	N/A	>15s
Variable Persistance	3 div/μs	N/A	>15s

*1 *Center 6 x 8 division; 0.9 cm/division.*

*2 *These times are at full-stored display intensity; they can be extended at least 25 times using reduced intensity in Save Display Mode.*

*3 *Center 8 x 10 division; 0.45 cm/division.*

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C. Forced air ventilation is provided.

Altitude — Operating: To 4600 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5,000 to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

Humidity — Operating and Nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, Class 4).

Shock — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 V	1% +0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	≈1 kHz	

Vertical Signal Output — CH 1 vertical signal is dc to at least 50 MHz and ≈25 mV/div terminated into 50 Ω, and ≈50 mV/div terminated into 1 MΩ.

Gate Outputs — Positive gates from both time bases (≈5 V).

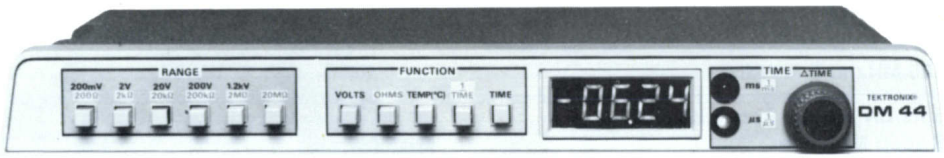
Power Requirements — Quick-Change Line Voltage Selector Provides Six Ranges: 110 V, 115 V, 120 V, 220 V, 230 V, and 240 V, each ±10%. 48 Hz to 440 Hz, 100 W maximum at 115 V and 60 Hz. Operation from 12 V to 24 V dc is available with Option 07.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width (with handle)	330	13.1
Height (without pouch)	159	6.2
Depth (with panel cover)	550	21.7
Depth (handle extended)	597	23.8
Weights ≈	**kg**	**lb**
Net (without panel cover or accessories)	11.8	26.0
Net (with panel cover and accessories)	13.5	29.8
Shipping	18.8	41.5

INCLUDED ACCESSORIES

Two P6062B Probes (010-6062-13); blue accessory pouch (016-0535-02); clear pouch (016-0537-00); CRT light filter (337-1674-01); two 1½ A fuses (159-0016-00); one ¾ A fuse (159-0042-00); ground wire adaptor (134-0016-01); viewing hood (016-0592-00); service manual; operator's manual.



DM 44
Differential-Time/DMM Option

For the 466/464

3½ Digit LED Display

Time Intervals Accurate to 1%

Frequency Accurate to 2%

Dc Voltage Measurements Accurate to 0.1%

Resistance Accurate to 0.3%

Temperature from −55°C to +150°C

One percent timing measurements were never this easy! With the DM 44 Option time intervals can be read directly from the 3½ digit LED screen. Simply use the Delay Time control and the ΔTime Dial to superimpose the end of the interval on the beginning. Then read its differential time or frequency from the 3½ digit LED panel. It's that simple. Time intervals are accurate to 1% and the frequency of periodic waveforms can be read out with 2% accuracy by simply pushing the 1/Time button.

Compare the DM 44 sequence with the measurement technique you may now be using. Calculating the interval from the CRT may take 10 times as long.

Voltage, resistance, and temperature measurements are also much easier with a DM 44. It measures dc voltage with 0.1% accuracy, resistance with 0.3% accuracy, and temperature from −55°C to 150°C. Previously, you would have needed a separate DMM and digital thermometer in addition to your oscilloscope. Now, these features are combined in one small, inexpensive, integral package.

CHARACTERISTICS

TIMING MEASUREMENTS (WITH 464 AND 466)

Differential Time Delay Accuracy

+15°C to +35°C	−15°C to +55°C
Within 1% of reading ±1 count	Within 2.5% of reading ±1 count

1/Time Accuracy

+15°C to +35°C	−15°C to +55°C
Within 2% of reading ±1 count	Within 3.5% of reading ±1 count

DC Voltage

Ranges — 0-200 mV, 0-2 V, 0-20 V, 0-200 V, 0-1.2 kV.

Resolution — 100 μV.

Accuracy — Within 0.1% of reading ±1 count.

Input Resistance — 10 MΩ for all ranges. Removal of an internal strap increases resistance to ≈1000 MΩ on 200 mV and 2 V ranges.

Normal-Mode Rejection Ratio — At least 60 dB at 50 Hz and 60 Hz.

Common-Mode Rejection Ratio — At least 100 dB at dc, 80 dB at 50 Hz and 60 Hz.

Recycle Rate — ≈3.3 measurements/s.

Response Time — Within 0.5 s.

Maximum Safe Input Voltage — ±1200 V dc + peak ac between + and common inputs or between + and chassis. ±500 V (dc + peak ac) common floating voltage between common and chassis.

Resistance

Ranges — 0-200 Ω, 0-2 kΩ, 0-20 kΩ, 0-200 kΩ, 0-2 MΩ and 0-20 MΩ.

Resolution — 0.1 Ω.

Accuracy

Range	Accuracy
200 Ω	within 0.25% ±1 count + probe resistance
2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ	within 0.25% ±1 count
20 MΩ	within 0.3% ±1 count

Recycle Rate — ≈3.3 measurements/s.

Response Time

200 Ω through 200 kΩ ranges	within 1 s
2 MΩ ranges 20 MΩ ranges	within 5 s

Maximum Safe Input Voltage — 120 V RMS between + and common inputs.

Temperature Using P6430 Probe

Range — −55°C to +150°C.

Accuracy

DM 44 Temperature	P6430 Tip Temperature	Accuracy (Probe Calibrated to DM 44)
+15°C to +35°C	−55°C to +150°C	±2°C
−15°C to +55°C	−55°C to +125°C +125°C to +150°C	±3°C ±4°C

INCLUDED ACCESSORIES

One pair test leads (003-0120-00); one P6430 Temperature Probe (010-6430-00); service manual; operator's manual.

ORDERING INFORMATION

466 Storage Oscilloscope **$7,090**
466 DM 44 Storage Oscilloscope/DMM **$7,640**
464 Storage Oscilloscope **$5,695**
464 DM 44 Storage Oscilloscope/DMM **$6,245**

INSTRUMENT OPTIONS

Option 01 — Delete DM 44 Temperature Probe (466DM 44, 464DM 44 Only) ..... −$90
Option 04 — EMC Modification ..... +$180
Option 05 — TV Sync Separator (Provides Triggering on TV Field) ..... +$350
Option 07 — External Dc Operation (Not for DM 44) +$300

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz

OPTIONAL ACCESSORIES

1106 — Battery Pack (Used with Option 07) **$1,040**
1105 — Battery Power Supply (See page 313) **$1,430**
Mesh Filter — Improves display contrast in high ambient light. Order 378-0726-01 ..... **$55**
Protective Cover — Waterproof vinyl (For 464/466) Order 016-0365-00 ..... **$21**
Folding Viewing Hood — Order 016-0592-00 ..... **$12**
Folding Binocular Hood — Order 016-0566-00 ..... **$15**
Polarized Collapsible Viewing Hood Order 016-0180-00 ..... **$40**
SCOPE-MOBILE® Cart — Occupies <18 inches aisle space, has storage area in base. Order 200D or 200C **$320**
Rack Adaptor — (Not for DM 44) Order 016-0676-00 ..... **$325**

RECOMMENDED CAMERA

C-30BP Option 01 General Purpose Camera Includes 016-0301-01 mounting adaptor/corrector lens. Order C-30BP Option 01 ..... **$1,417**
Camera Adaptor — Mounts C-30B Series Camera to 464/466 Oscilloscopes. Order 016-0301-01 ..... **$85**
For further information see camera section.

Modification kits for field conversion of existing 466s and 464s to Option 07 or DM 44 equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, Distributor, or Representative for information.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

434

25 MHz at 10 mV/div

20 ns/div Sweep Rate with X50 Sweep Magnifier

Weighs ≈9.4 kg (20.8 lb)

A bistable, split-screen storage oscilloscope with a 25 MHz bandwidth, the compact 434 fills many needs. The split screen provides full-screen storage, or upper or lower screen storage, with the other half conventional.

Tektronix 434s are used for maintaining display boards, video monitors, automatic baggage handling systems, X-ray systems, and air-conditioning and heating systems.

CHARACTERISTICS

VERTICAL DEFLECTION

(2 Identical Channels)

Bandwidth and Risetime (From 50 Ω Terminated Source, With or Without 10X Probe) — Dc to at least 25 MHz at 3 dB down*1, 14 ns from 10 mV/div to 10 V/div, decreasing to 15 MHz, 22 ns at 1 mV/div. Low frequency 3 dB down point with ac coupling is 14 Hz or less (<1 Hz with 10X probe).

Deflection Factor — 1 mV/div to 10 V/div, accurate ±3%. Uncalibrated, continuously variable between steps and to ≈25 V/div.

Display Modes — CH 1 only, CH 2 only (normal or inverted), alternate, chopped (≈100 kHz), added.

Common-Mode Rejection Ratio — At least 20 dB at 10 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are indicated by lights besides the knob skirts. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2% paralleled by ≈24 pF.

Maximum Imput Voltage — Dc Coupled: 250 V (dc + peak ac). Ac Coupled: 500 V (dc + peak ac). In either mode the maximum ac is 500 V p-p at 1 kHz or less.

Delay Line — Permits viewing of leading edge of displayed waveform.

*1 *Bandwidth derated to 22 MHz above +30° C.*

HORIZONTAL DEFLECTION

Time Base — 0.2 μs/div to 5 s/div (1-2-5 sequence). X50 magnifier extends fastest sweep rate to 20 ns/div.

Variable Time Control — Uncalibrated, continuously variable between steps and to 12.5 s/div.

Time Base Accuracy*1

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±4%	±5%

*1 *Full 10 divisions*

External Horizontal Input — Deflection factor is ≈0.5 V/div. Input resistance is ≈50 kΩ.

TRIGGER

Modes — Auto trigger (sweep free-runs in absence of triggering signal, normal trigger, single sweep).

Trigger Sensitivity and Coupling

Coupling	To 5 MHz	At 25 MHz
Dc Internal	0.3 div deflection	1 div deflection
Dc External	50 mV	125 mV
Ac	Requirements increase below 20 Hz	
Ac LF Reject	Requirements increase below 50 kHz	
Ac HF Reject	Requirements increase above 50 Hz	

Sources — CH 1 only, composite line, external and external ÷10. External trigger level range is at least +2 V to −2 V or +20 V to −20 V.

External Inputs — Input R ≈1 MΩ paralleled by 100 pF ÷1 or 70 pF ÷10. 250 V (dc + peak ac).

DISPLAY

CRT — 8 x 10 div (1 div = 0.975 cm) horizontal and vertical divisions further marked in 0.2 div increments. GJ (P1) Phosphor. 4 kV accelerating potential.

Graticule — Internal, nonparallax; nonilluminated.

Beam Finder — Compresses trace to within graticule area for ease in locating an off-screen signal.

Z-Axis Input — Dc coupled, positive going signal decreases intensity, 5 V p-p signal causes noticeable modulation; dc to 20 MHz usable frequency range.

STORAGE FEATURES

Display Modes — Split-screen with storage on upper or lower half of screen with conventional display on other half. Storage on entire screen or conventional display. Independent operation of halves.

Stored Writing Speed (Center 8 Div) — Normal, 100 div/ms. Enhanced, increases single-sweep storage writing speed to at least 400 div/ms. (Option 01, 500 div/ms, normal; to 5000 div/ms, enhanced).

Erase Time — 300 ms or less.

Locate — Beam can be positioned left of the graticule area to determine vertical position of next sweep without disturbing stored display.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: To 4600 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5,000 to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

Humidity — Operating and Nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.1, class 4).

Shock — Operating and nonoperating: 30 g's, 1/2 sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.6 V ±1.0%, 1 kHz ±1.0% (+20°C to +30°C). Output resistance is 575 Ω.

Power Requirements — Operates on all voltages from 90 V to 136 V and 180 V to 272 V, 48 Hz to 440 Hz, 60 W maximum. Also operates from 220 V dc to 350 V dc.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width (with handle)	330	13.0	483	19.0
Height (w/o pouch)	142	5.6	133	5.3
Depth	475	18.7	457	18.0
Weight ≈	**kg**	**lb**	**kg**	**lb**
Net	9.4	20.8	10.5	23.1
Shipping	13.6	30.0	22.0	49.0

INCLUDED ACCESSORIES

Two P6105 Probes (010-6105-03); accessory pouch (016-0165-00); service manual; operator's manual. Rack models also include mounting hardware and slide out assemblies, but not pouch.

ORDERING INFORMATION

434 Storage Oscilloscope **$5,150**

R434 Rackmount Storage Oscilloscope **$5,305**

Option 01 — Increased Writing Speed ..... **+$400**

OPTIONAL ACCESSORIES

Probes

Probe Type	Attenuation	Input Impedance	Bandwidth*1
P6062B 6 ft	1X	1 MΩ 5 pF	6.7 MHz
	Switchable 10X	10 MΩ 14 pF	25 MHz
P6122 1.5 m	10X	10 MΩ 11pF	25 MHz
Current Probe	**Calibration**	**Insertion Impedance**	**Bandwidth with 434**
P6022 5 ft	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω at 1 MHz Increasing to 0.2 Ω at 120 MHz	25 MHz

*1 *Bandwidths are measured at the upper −3 dB, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth.*

1105 Battery Power Supply (See page 314) **$1,430**

Mesh Filter — Improves contrast and EMC filtering. Order 378-0682-00 ..... **$60**

Portable to Rackmount Assembly — Includes hardware for standard 434 in 19 in rack mounting. Order 016-0272-00 ..... **$200**

Folding Polarized Viewing Hood — Order 016-0180-00 **$40**

SCOPE-MOBILE® Cart — Occupies <18 inches aisle space, has storage area in base. Order 200D or 200C **$320**

RECOMMENDED CAMERA

C-30BP Option 01 General Purpose Camera — Includes mounting adaptor/corrector lens (016-0301-01). Order C-30BP Option 01 ..... **$1,417**

For further information see camera section.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

SONY®/TEKTRONIX® 10 MHz DUAL TRACE STORAGE OSCILLOSCOPE

314

10 MHz at 1 mV/div

100 ns/div Sweep Rate with X10 Sweep Magnifier

Stored Viewing Time to 4 Hours

Integrate Mode for Intensifying Fast Risetime, Low Repetition Rate Signals

Operates from Ac Line, 12 V Dc, or 241 V Dc

Small Size, Weighs ≈4.7 kg (10.5 lb)

The 10.5 pound, bistable storage 314 provides 1 mV/div sensitivity at 10 MHz, with a four hour viewing time. With long-term storage, you can use the 314 to monitor signal lines where undesired transients are suspected.

For fast risetime, low repetition rate signals, an integrate mode increases the intensity of the stored trace.

Compact size and operation from ac or external dc source mean that the 314 will easily go wherever you need a storage oscilloscope.

Combined function controls, color coding, and functional front-panel layout make the 314 easy to use. Probes mount on the side, permitting an uncrowded front panel and large CRT.

The 1 mV/div sensitivity is particularly useful for measurement of transducer signals such as those from magnetic recording heads. An autoerase mode, with variable erase period from 1 to 5 seconds, enhances the ability of the 314 to make measurements on slowly changing analog signals such as those from a pressure transducer. Other applications for the 314 occur in industrial control systems, biophysical instrumentation, communication terminals, POS terminals, computer peripherals, and communication systems.

CHARACTERISTICS

VERTICAL DEFLECTION

Bandwidth and Risetime — Dc to at least 10 MHz. Risetime: 35 ns or less for a 4 div step input. For ac coupling, the lower 3 dB point is 10 Hz or less.

Deflection Factor — 1 mV/div to 10 V/div (1-2-5 sequence), accurate ±3%. Continuously variable between steps and to at least 25 V/div (uncalibrated).

Display Modes — CH 1, CH 2 (normal or inverted), chopped, alternate, added, and X-Y.

Input R and C — 1 MΩ paralleled by ≈47 pF.

Maximum Input Voltage — Ac or dc coupled, 300 V (dc + peak ac).

Delay Line — Permits viewing leading edge of displayed waveform.

Amplitude Calibrator — 0.5 V accurate ±1% from 20°C to 30°C, ±2% from −15°C to +55°C.

HORIZONTAL DEFLECTION

Time Base — 1 μs/div to 5 s/div. X10 magnifier extends sweep rate to 100 ns/div.

Variable Time Control — Uncalibrated, continuously variable between steps and to at least 12.5 s/div.

Time Base Accuracy[*1]

Unmagnified	
1 μs/div to 0.2 s/div	±3%
0.5 s/div to 5 s/div	±4%
Magnified	
50 ms/div to 0.5 s/div	±5%
0.5 μs/div to 20 ms/div	±4%
0.1 μs/div and 0.2 μs/div	±5%

*[*1] Center 8 divisions*

TRIGGER

Modes — Normal (sweep generator requires a trigger to generate a sweep). Automatic (minimizes trigger adjustment). Sweep generator free-runs in the absence of a trigger. Single sweep (one sweep is initiated by the first trigger after a reset).

Trigger Sources — Internal: CH 1, CH 2 or composite, external.

Sensitivity and Coupling

Coupling	1 MHz	10 MHz
Dc Internal	0.3 div deflection	1 div deflection
Dc External	150 mV	500 mV
Ac	Requirements increase below 30 Hz	
Ac LF Reject	Requirements increase below 50 kHz	

X-Y OPERATION

Input — X-axis input is via the external horizontal input connection. Both CH 1 and CH 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.

X-Axis Deflection Factors — Continuously variable from 20 mV/div to 2 V/div. Bandwidth, dc to at least 200 kHz.

Input Impedance — 1 MΩ ±2% paralleled by ≈62 pF.

DISPLAY

CRT — 8 x 10 div (0.6 cm/div) display. GX (P44) Phosphor. 2 kV accelerating potential.

Graticule — Internal, nonilluminated. Vertical and horizontal centerlines marked in 5 minor div per major 0.6 cm/div.

Z-Axis Input — Range +5 V to +20 V (dc coupled) with a 100 kHz or greater usable frequency range. Maximum input voltage, 50 V (dc + peak ac).

STORAGE FEATURES

Display Modes — Direct view, bistable storage, and nonstore modes. Enhance mode to increase stored writing rate in the single sweep mode. Autoerase mode to automatically erase stored display after each sweep. Viewing time before autoerase can be varied from 1 s or less to at least 5 s. Integrate mode increases stored brightness of very fast repetitive signals.

Stored Writing Speed — Normal, at least 80 div/ms. Enhanced, increases to at least 400 div/ms (250 cm/ms) in enhanced mode.

Erase Time — 300 ms.

AC POWER REQUIREMENTS

Line Voltage Ranges — 90 V ac to 130 V ac or 180 V ac to 264 V ac.

Line Frequency — 48 Hz to 440 Hz.

Power Consumption — 29 W maximum at 115 V ac.

External Dc Source — +11 V dc to +14 V dc or +22 V dc to +28 V dc.

Dc Current Drain — 1.6 A at +12 V or 0.8 A at +24 V.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −40°C to +75°C.

Altitude — Operating: To 6000 m (20,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5000 ft to 20,000 ft. Nonoperating: 15 000 m (50,000 ft) maximum.

Vibration — Operating: 15 minutes along each of the three major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

Humidity — Nonoperating: 5 cycles (120 hours) of MIL-Std-202D, Method 106C. Omit freezing and vibration and allow a post-test drying period at 25°C ±5°C and 20% to 80% relative humidity.

Shock — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration each direction along each major axis. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width (with handle)	236	9.3
Height (without pouch)	112	4.4
Depth (handle not extended)	347	13.6
Depth (handle extended)	448	17.6
Weight ≈	**kg**	**lb**
Net (without accessories)	4.7	10.5
Shipping	7.6	17.0

INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03); carrying case and pouch (016-0612-00); strap (346-0131-00); external dc cable assembly (012-0406-00); two 1.6-A fuses (159-0098-00); two 0.8-A fuses (159-0132-00); two 0.15-A fuses (159-0130-00); three 0.16-A fuses (159-0131-00); service manual; operator's manual.

ORDERING INFORMATION

314 Storage Oscilloscope **$3,800**

The SONY®/TEKTRONIX® 314 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 314 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

RECOMMENDED CAMERA

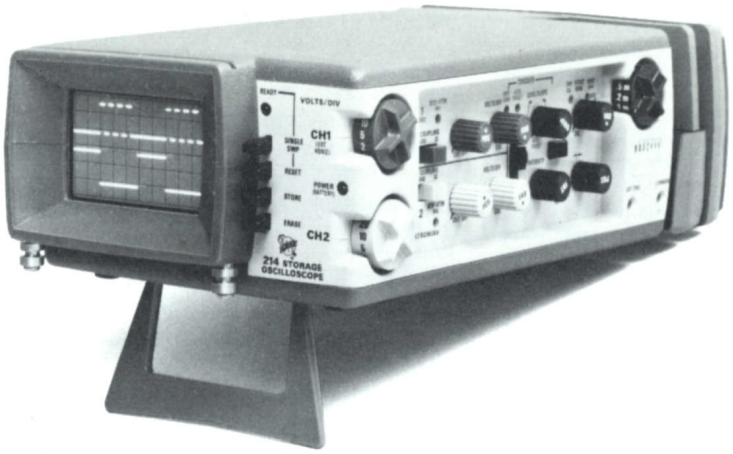
C-30BP General Purpose Camera **$1,375**

Camera Adaptor — Mounts C-30BP to 314.
Order 016-0327-01 ..... **$170**

For further information see camera section.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

500 kHz DUAL TRACE STORAGE OSCILLOSCOPE



214

500 kHz, 1 mV/div to 50 V/div

Internal Battery

Integral 1 MΩ Probe

Weighs ≈1.6 kg (3.5 lb)

The 214 features these signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is lightweight (only 3.5 pounds) and compact (3 x 5.3 x 9.5 inches). The 214 offers bistable storage capabilities. This is useful for viewing nonrepetitive or slow moving signals.

Built of impact-resistant plastic and fully self contained, this miniature portable is ideal for applications in severe environments. And it permits "floating" measurements since it is double insulated and can be elevated to 700 V (dc + ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 214 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument—you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

In the single sweep mode the 214 can be set to wait for, then record, a single event. With this feature, the scope's sweep circuit is armed and will wait for the signal to arrive before it runs. When the signal occurs, the sweep runs once. When combined with storage, this provides the unique capabilities of automatically waiting for an event and then storing it for subsequent viewing.

CHARACTERISTICS

VERTICAL DEFLECTION

Bandwidth — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower −3 dB point ac coupled is <2 Hz.

Deflection Factors — 1 mV/div to 50 V/div (1-2-5 sequence), accurate ±5%. Uncalibrated, continuously variable between steps to at least 125 V/div.

Display Modes — CH 1 only, CH 2 only, or CH 1 and CH 2 chopped (≈ chop rate — 40 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

Input R and C — ≈1 MΩ paralleled by ≈160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

Maximum Input Voltage[*1]

1 mV/div to 50 mV/div	600 V (dc + peak ac) ac not over 2 kHz
0.1 V/div to 50 V/div	600 V (dc + peak ac) 600 V p-p ac; 5 MHz or less

*[*1] 1X Probe Only*

HORIZONTAL DEFLECTION

Time Base — 5 μs/div to 500 ms/div, accurate ±5%.

Variable Magnifier — Increases each sweep rate X5 with a maximum sweep speed of 1 μs/div.

External Horizontal Input — (CH 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz <3°. Input characteristics same as CH 1.

Maximum External Horizontal Input Voltage and Impedance — Same as for vertical inputs.

Input Impedance — R and C, 1 MΩ paralleled by ≈30 pF.

TRIGGER

Trigger Modes (Automatic or Normal) — Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Trigger Sensitivity and Coupling

Dc Coupling	To 500 Hz
Internal (w/composite trigger source)	0.2 div
Internal (w/CH 2 trigger source)	0.2 div
External	1 V

Maximum External Trigger Input Voltage — 8 V (dc + peak ac), 16 V (p-p) at 1 MHz or less.

Single Sweep — Sweep generator produces one sweep when trigger is received.

DISPLAY

CRT — Bistable storage, 6 x 10 div (0.52 cm/div) display. GX (P44) Phosphor.

Graticule — Internal, black line, nonilluminated.

STORAGE FEATURES

Stored Writing Speed — Normal, at least 80 div/ms. Enhanced, increases single-sweep storage writing speed to at least 500 div/ms. Enhance is automatic from 0.1 ms to 5 μs/div in single sweep.

Stored Luminance — At least 8 fL at 25°C.

Storage Viewing Time — ≈1 hour.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating (Battery Only): −15°C to +55°C. Charging or Operating From Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: 7600 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

Humidity — 5 cycles (120 hours) to 95% relative humidity, referenced to MIL-E-16400F.

Shock — Operating and Nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Power Sources — Internal NiCd batteries provide ≈3.5 to 5 hours operation (≈2.5 to 3.5 hours in 214 stored mode) for a charging and operating temperature between 20°C and 30°C. Internal charger charges the batteries when connected to an ac line with instruments turned off. Battery operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about 5 minutes of operating time remaining in the batteries.

External Ac Source — 110 V to 126 V, 58 Hz to 62 Hz, 3 W. Can be operated at 104 V to 110 V with resulting slow discharge of internal batteries.

Insulation Voltage — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4X line voltage + dc + peak ac not to exceed 350 V.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	133	5.3
Height	76	3.0
Depth	241	9.5
Weight≈	**kg**	**lb**
Net (without accessories)	1.6	3.5
Shipping	3.2	7.0

INCLUDED ACCESSORIES

Viewing hood (016-0199-01); carrying case (016-0512-00); two 4-A fuses (159-0121-00); identification tags (000-7983-00); identification tag (334-2614-00); carrying strap (346-0104-00); service manual; operator's manual.

ORDERING INFORMATION

214 Dual-Trace Storage Oscilloscope, Includes Batteries and Probes **$2,410**

POWER OPTIONS

Option 01 — For 220 V to 250 V (48 Hz to 52 Hz) Includes Batteries ..... **NC**

Option 02 — For 90 V to 110 V (48 Hz to 52 Hz) Includes Batteries ..... **NC**

OPTIONAL ACCESSORIES

10X Attenuator Package — A slip-on tip to provide lower circuit loading (4.4 MΩ, ≈20 pF) and higher maximum input voltage 1000 V (dc + peak ac). Includes: flex tip (206-0060-00); 10X attenuator (010-0378-01); pincher tip (013-0071-00); banana tip (134-0013-00); IC adaptor (206-0203-00). Order 010-0378-01 ..... **$47**

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large (up to ⅜ in) conductors. Includes: 6-32 to probe adaptor (103-0051-01); red clip (015-0229-00); yellow clip (015-0230-00). Order 015-0231-00 ..... **$20**

Probe-Tip — To BNC Panel Connector Adaptor. Order 013-0084-01 ..... **$8.00**

Probe-Tip to BNC Cable Adaptor. Order 103-0096-00 ... **$11**

Power Cable Adaptor Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 ..... **$7.00**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

T912

10 MHz at 2 mV/div

250 cm/ms Stored Writing Speed

50 ns/div Sweep Rate (with X10 Sweep Magnifier)

8 x 10 cm Bistable Storage CRT

Weighs ≈7.9 kg, (17.5 lb)

Differential Input Option

The T912 Storage Oscilloscope is well suited for a wide range of applications in education and industry. As a training aid in basic electricity and electronics courses, the storage feature is highly useful in creating visual representations of electrical signals. In physics and engineering courses, storage permits the user to capture and display single-shot events like the pressure curve generated in the compression chamber of an engine or the stress-strain characteristics of a material undergoing destructive testing.

The T912 has similar industrial applications, where it can also be used to compare input vs feedback signals in servo-mechanisms for shock and vibration analysis, and countless other transducer-aided measurements.

Besides bistable storage, the T912 offers other features seldom found in economy-model oscilloscopes including a delay line, that allows you to view the leading edge of fast-rising signals, a 12-step calibrated vertical attenuator and constant bandwidth throughout the sensitivity range of 10 V to 2 mV per centimeter. Additional features include 19 calibrated sweep rates ranging from 0.5 s to 500 ns/cm, 3% amplitude and timing accuracy; and minimal corner shift over a broad vertical dynamic range.

The T912 may be ordered with a differential input option. In Diff mode, the T912 displays the difference between CH 1 and CH 2 signals. The CH 2 signal is automatically inverted. The algebraic sum of the CH 1 signal and the inverted CH 2 signal is then displayed on the CRT.

CHARACTERISTICS

VERTICAL SYSTEM

Mode Selection — CH 1: Displays only the CH 1 signal. CH 2: Displays only the CH 2 signal. Dual Trace: Displays CH 1 and CH 2 signals simultaneously. Alternate or chopped mode is automatically selected by the Sec/Div control setting, chopped mode is selected for settings ≥1 ms/div, alternate for settings ≤500 μs/div. Trigger is derived from CH 1 signal only.

Deflection Factor Range — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence. Continuously variable between settings, to at least 25 V/div.

Accuracy

+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

Frequency Response — Dc to at least 10 MHz (measured at −3 dB).

Risetime — 35 ns or less.

Chopped Mode Repetition Rate — ≈250 kHz.

Input Resistance — ≈1 MΩ.

Input Capacitance — ≈30 pF.

Maximum Input Voltage — Dc Coupled: 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less. Ac Coupled: 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Delay Line — Permits viewing edge of displayed waveform.

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.5 μs/div in 19 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends maximum sweep rate to 50 ns/div.

Accuracy

	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +45°C	Within 4%	Within 6%

Trigger Modes — Auto: Permits normal triggering on waveforms with repetition rate of at least 20 Hz. Sweep "free-runs" in the absence of adequate trigger signal, or one with a repetition rate below 20 Hz. Normal: Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal. Single Sweep: Displays one sweep only. Sweep cannot be triggered again until reset. Slope + Out − In: Sweep is triggered on the positive/negative-going slope of the triggering waveform. Level: Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Trigger Sensitivity — Auto and Normal: 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 10 MHz.

External Trigger Input — Maximum Input: 400 V (dc + peak ac) 800 V p-p ac at ≤1 kHz. Input Resistance: ≈1 MΩ. Input Capacitance: ≈30 pF.

X-Y OPERATION

Sensitivity, Variable Magnifier — ≈100 mV/div (X10 magnifier), ≈1 V/div (X1 magnifier), for X; Y is adjusted by vertical control.

X-Axis Bandwidth — Dc to at least 1 MHz (measured at −3 dB).

Input Resistance — ≈1 MΩ.

Input Capacitance — ≈30 pF.

Phase Difference Between X and Y Axis Amplifiers — Within 5° from dc to 50 kHz.

CRT STORAGE DISPLAY

Writing Rate — At least 25 cm/ms.

Enhanced Writing Rate — At least 250 cm/ms.

Display Area — 8 cm x 10 cm, internal graticule.

Storage Phosphor — GJ (P1).

Beam Finder — Locates off-screen display.

Nominal Accelerating Potential — ≈2.76 kV.

AC POWER REQUIREMENT

Line Voltage Ranges — HI-LO range accessible externally; 110 V to 120 V, 220 V to 240 V line selector visible but not accessible externally.

100 to 120 V Range — HI: 108 V RMS to 132 V RMS. LO: 90 V RMS to 110 V RMS.

220 to 240 V Range — HI: 216 V RMS to 250 V RMS. LO: 198 V RMS to 242 V RMS.

Line Frequency — 50 Hz to 60 Hz.

Power Consumption — 65 W maximum, 0.6 A maximum, at 120 V, 60 Hz.

PROBE ADJUST

Output Voltage — ≈0.5 V.

Repetition Rate — ≈1 kHz.

Z-AXIS INPUT

Sensitivity — 5 V causes noticeable modulation.

Usable Frequency Range — Dc to 5 MHz.

Input Impedance — ≈10 kΩ.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Nonoperating: −55°C to +75°C. Operating: 0°C to +45°C.

Altitude — Nonoperating: To 15 000 m; (50,000 ft). Operating: To 4600 m; (15,000 ft) maximum. Operating temperature decreased 1°C/304.8 m (1,000 ft) above 1524 m (5,000 ft).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	180	7.1
Height	254	10.0
Depth	475	18.7
Weight ≈	**kg**	**lb**
Net (with panel cover)	8.2	18.0
Net (without panel cover)	7.9	17.5

INCLUDED ACCESSORIES

3.5 ft P6006 10X Probe (010-0127-00); 2 m P6006 10X Probe (010-0160-00); service manual; operator's manual.

ORDERING INFORMATION

T912 — Storage Oscilloscope **$2,255**

Option 01 — Differential Input ..... **+$110**

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

OPTIONAL ACCESSORIES

Protective Front Panel Cover — Snaps over the oscilloscope front panel to protect controls during transport or storage. Molded from high-impact-resistant plastic. Storage compartment for two probes and cables is built into inner side. Order 016-0340-00 ..... **$20**

Dust Cover/Rain Jacket (Not Shown) — Provides protection against dust accumulation when not in use, and against rain and snow during transportation. Constructed of 15 mil tough durable vinyl. An opening at the top allows access to the oscilloscope handle. Order 016-0361-00 ..... **$20**

C-5C Camera (Not Shown) — Order C-5C, Option 03 . **$530**

P6122 — 10X Passive Probe. Order 010-6122-01 ..... **$77**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

AUTOMATED TEST SYSTEMS INSTRUMENTS

Tektronix offers a variety of programmable measurement instruments to meet your measurement needs. Starting with a wide performance base of GPIB compatible waveform digitizers, with capabilities up to 14 GHz. And, with the 7D20 digitizer plug-in, your existing Tektronix 7000 Series oscilloscope can become a GPIB programmable waveform digitizer—another example of our designed-in commitment to expandability.

Plus, we have a broad range of other GPIB programmable instruments to complete your system—signal and power sources, measurement devices, switchers, spectrum analyzers, multifunction interface units. And they are all supported by a selection of instrument controllers, peripherals, and software.

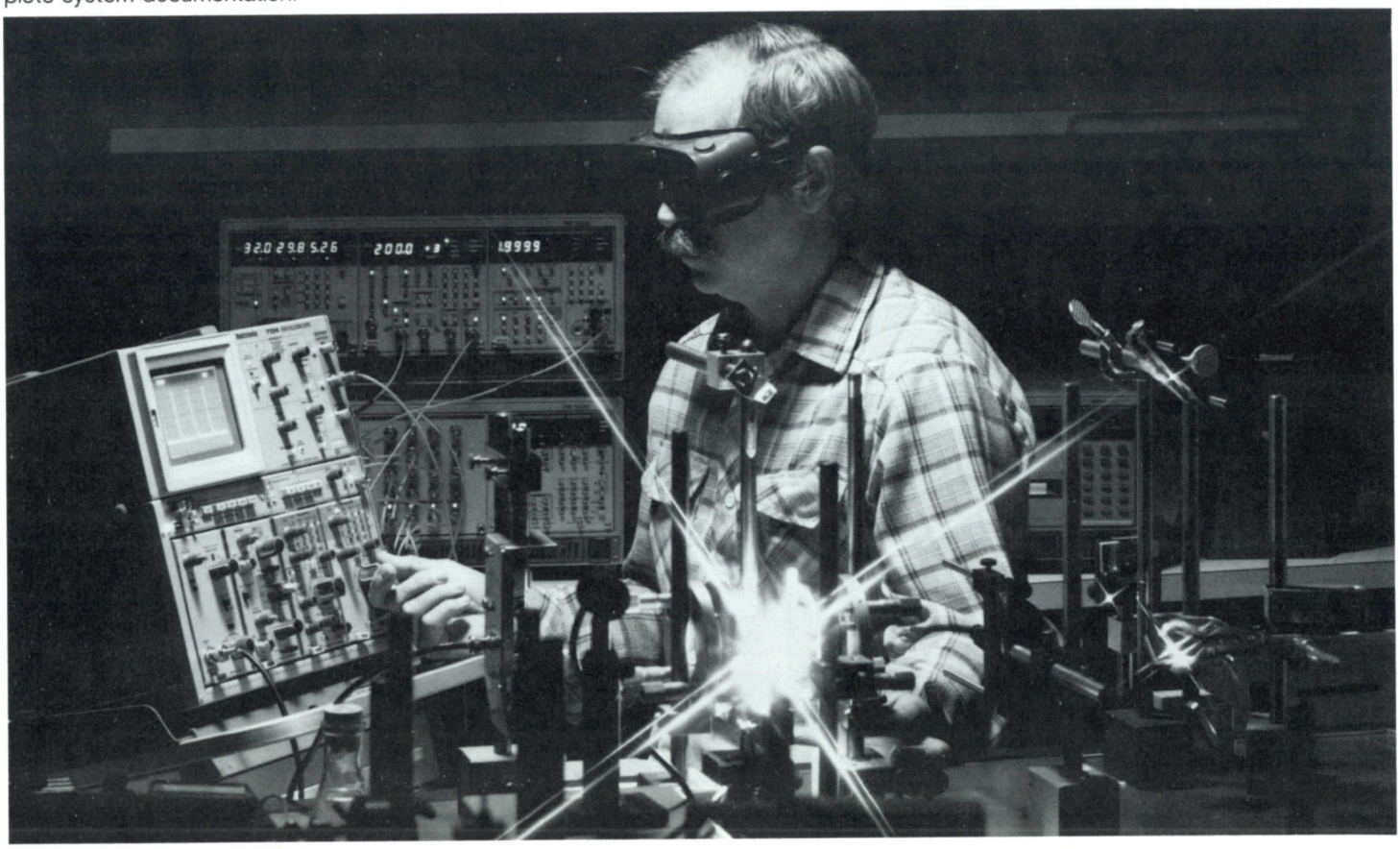
We have complete systems, too. From single instrument/controller combinations to multiple-instrument, multiple-bus configurations. These are fully integrated at our factory before shipping and supplied with complete system documentation.

And we provide extensive and ongoing documentation—hardware and software manuals, controller programming guides, instrument interfacing guides, application notes, even a regular newsletter on signal processing and instrument control. In addition, an instrumentation software library provides programs to help you develop measurement software to solve your measurement problems.

Whatever your measurement needs, from a single GPIB instrument to an entire system, we're sure you'll find the right measure of performance in the following pages. Take the time to discover what capabilities are available. Then call your Tektronix Sales Engineer for complete details and specifications. You'll be making an investment in performance that will pay dividends for years to come.

CONTENTS

Programming Ease 328
Utility Software 330
Controllers and Peripherals 331
Digitizers 336
Signal Processing Systems 353
TM 5000 Modular Instruments 358



PROGRAMMING EASE . . .

Another Order of Magnitude in Measurement Convenience

Tektronix *Standard Codes and Formats...* A Commitment to Compatibility

Tektronix Programmable Instruments Speak Your Language

With Tektronix programmable instruments, compatibility is the key. And it's more than just IEEE Standard 488 compatibility. It's total system compatibility, from configuring to programming. This higher level of compatibility is achieved through conformance to the additional standard of Tektronix *Standard Codes and Formats*. Tektronix *Standard Codes and Formats* extend compatibility through:

—An ASCII-coded language for easy, English-like programming.
—Command names that are descriptive abbreviations of instrument functions for simple and direct instrument control.
—Universal message and data formats for instrument-to-instrument consistency.

In short, Tektronix programmable instruments speak a system language that is the same as your language.

Need to set your power supply to 5 volts?

It's easy with the TM 5000 Series PS 5010 Programmable Power Supply. Just send the message VPOS 5 over the IEEE-488 bus to the power supply, and it will change its positive output to 5 volts.

Want to set the negative supply to −9 volts? Just send VNEG 9, or even VNEG −9. All Tektronix programmable instrument commands are simple, English abbreviations for the instrument functions, with direct matches to the front-panel control labels where appropriate. So, if you know how to operate the instrument, you essentially know what commands to send it.

What could be simpler than DCV .2 to change your TM 5000 DM 5010 Programmable Multimeter to the 200 mV range for dc voltage measurements? Or ACV 2 to switch it to the 2 V range for ac measurements? But then, you may not always be sure of the range you need. So just send DCV or ACV without specifying the range, and the multimeter will auto-range to give you the best measurement. You don't have to learn a new language to speak to an instrument or understand instrument control messages—they're self documenting.

Getting Your Message Across

It doesn't take long to become familiar with the command set for any Tektronix programmable instrument. And, once you have that familiarity, you'll want to begin actually programming for automated measurements. First, though, you'll need to know something about IEEE-488 bus communication.

IEEE Standard 488 specifies overall bus functions, leaving many implementation options to designer discretion. One option is how controllers and instruments signal message endings to each other. Some controllers end messages by asserting End Or Identify (EOI) concurrent with sending the last character of a message, others by adding a line feed (LF) character and asserting EOI concurrent with that. For compatibility, your instruments and controller must use the same message termination mode.

Whatever your choice of IEEE Standard 488 instrument controller, Tektronix programmable instruments are designed for compatibility. A switch on each Tektronix programmable instrument lets you match it to your controller by selecting the EOI only or EOI/LF message termination mode. But, if you've chosen a Tektronix controller, you won't have to bother with this switch. All Tektronix-supplied instrument controllers use EOI only, and all Tektronix programmable instruments are shipped set for EOI only.

Along with the Message Terminator switch, you'll also find that each Tektronix programmable instrument has a bank of at least five additional switches. These are used to set the instrument's primary bus address.

For an IEEE Standard 488 system to work, each instrument on the bus must have a different address. Valid addresses range from 0 to 30, with 0 reserved in some cases for the controller. Before connecting your Tektronix programmable instrument to the IEEE-488 bus, make sure each instrument is set to a different address. For most instruments, address checks can be done with a front-panel button. Pressing the button causes the address to appear on the instrument's display. Some instruments also display their message terminator setting.

The primary address links the controller to a specific instrument. For example, when using a Tektronix 4050 Series Controller with 4050 BASIC Software, just primary addresses are used. 4050 BASIC automatically converts primary addresses to talk and listen addresses. For example, a 4050 BASIC statement to send VPOS 5 to a PS 5010 Programmable Power Supply with a primary address of 22 would have the following format:

```
PRINT @22:"VPOS 5"
```

PRINT is the 4050 BASIC statement for sending a message to an instrument. The instrument's primary address, 22 in this case, is always preceded in the statement by an "at" sign (@) and followed by a colon. The instrument message, VPOS 5, follows the colon and is always enclosed in quotes. Since the instrument will be receiving the message, PRINT causes the primary address to be automatically incremented to a listen address.

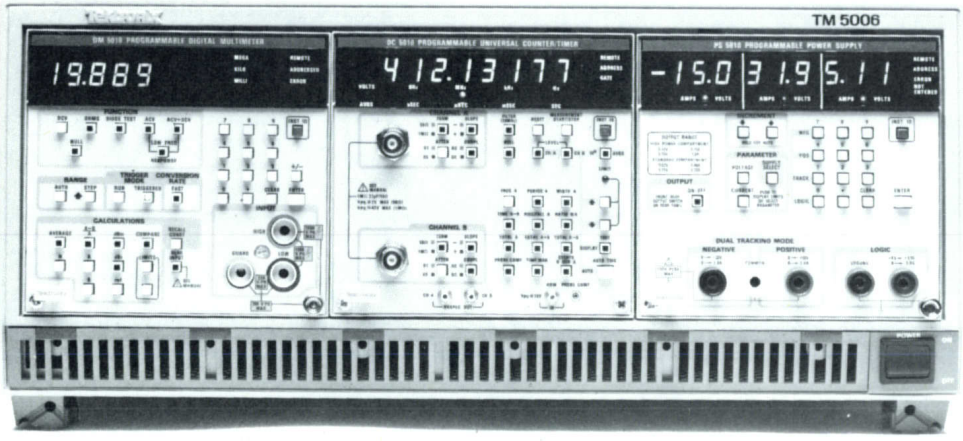
Keep in mind, though, PRINT @22:"VPOS 5" is a statement format specific to 4050 BASIC. Other instrument controllers and software packages may use different statement formats, however the device dependent message is always the same. For example, Print #22:"VPOS 5" does the same thing in 4041 BASIC.

We Interrupt This Message For a Brief Program

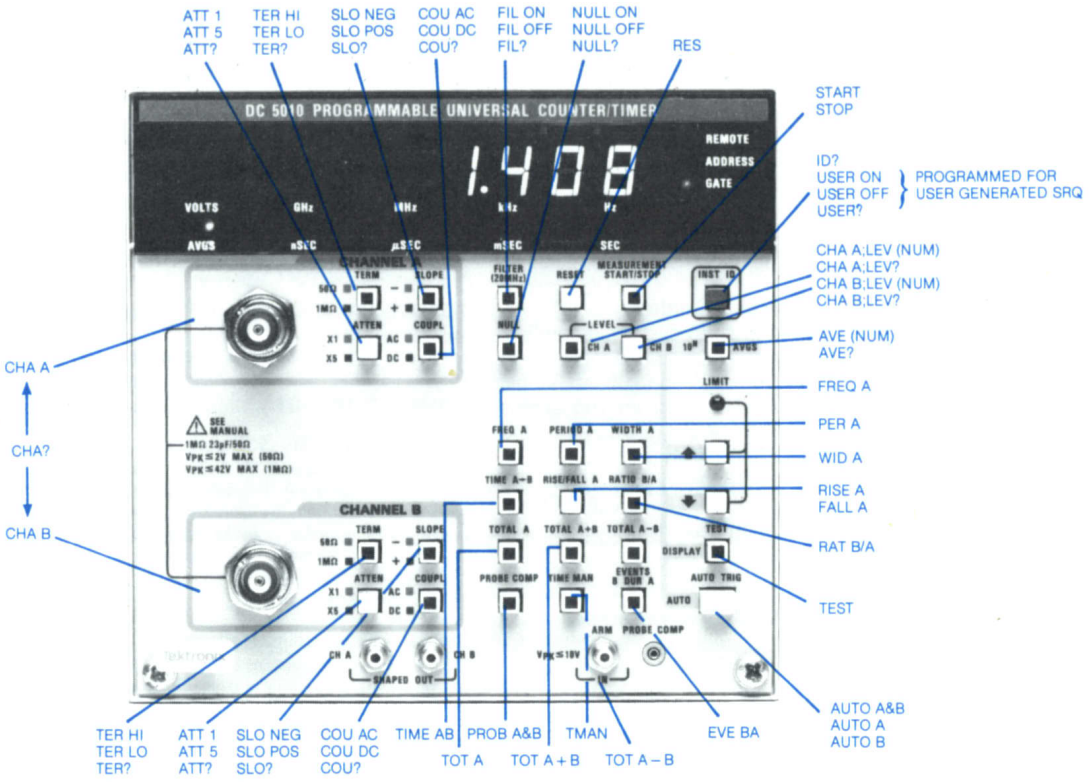
In addition to being easy to program, Tektronix programmable instruments are friendly and informative in respect to sending SRQ interrupts.

With the basic message format in mind, you are ready to begin sending messages to your instruments. However, you should be aware that your instruments can occasionally interrupt what you are doing by asserting what is called an SRQ (Service Request).

On some Tektronix programmable instruments, a front-panel button can also be programmed to generate an SRQ when pressed. This manually generated SRQ is a convenient way for you to interrupt and interact with a measurement program while it is running.



TM 5000: IEEE Standard 488 compatibility in an attractive, high-density package for minimum use of bench top or system rack space.



*Tektronix **Standard Codes and Formats** mean friendly "front panel" commands for easy programming.*

This can be done with a serial poll, which is demonstrated in the following 4041 BASIC program example:

```
100 ON SRQ(1) THEN GOSUB SRQHAN
110 PRINT #16:"ACV"
120 PRINT #10:"TR HOLDNEXT ON"
130 .
140 .
150 .
1000 SRQHAN: POLL STATUS;ADDRESS;16;10
1010 RESUME
```

Line 100 in the above example sets up a condition that calls the SRQ handler routine "SRQHAN" whenever an SRQ is asserted. In the absence of an SRQ, the normal path of the program is taken. However, on an SRQ, the program branches to the SRQHAN subprogram, which contains a Poll statement. The Poll statement checks each instrument in the order of listed addresses to find the one asserting SRQ. When it finds the instrument with SRQ asserted, it services the SRQ by reading the instrument's status message into the status variable (Status in the example Poll). Also, the instrument's address is placed in variable Address. (From these two variables, you can then tell which instrument asserted SRQ and why.) When the Poll completes, the Resume in line 1010 causes program execution to return to where it was when the SRQ caused the interrupt.

In an actual programming situation, you may want to check the status code variable, Status, and base some action on its value before returning to the main programs. To make this easier, Tektronix programmable instruments all use the same status codes for universal conditions. For example, no matter what Tektronix programmable instrument you are using, 66 is the code for operation complete. A full list of status codes and their meanings is provided in each instrument manual.

Tektronix programmable instruments also have an error code scheme that allows individual instruments to expand on the universal system status codes. This expansion is the result of an extensive message decoding system that checks for syntax errors, illegal combinations, etc., before messages are allowed to affect instrument operation. Illegal setups are prevented, and specific, rather than generalized, error codes are available for each instrument. These error codes can be read over the IEEE-488 bus by sending the instrument an error query message (ERR?) or the event query message (EVENT?). Together, SRQs, polling, and event queries are an extremely powerful set of programming tools for assessing and controlling measurement systems.

Queries Keep You Posted

Specific information about instrument settings, measurement modes, etc., can be obtained with various instrument query messages. All Tektronix *Standard Codes and Formats* queries take the form of a keyword followed by a question mark. You send the query to the instrument as a message, and the instrument answers the query by returning a message over the bus.

For example, here's a query sequence in 4041 BASIC statements to obtain the trigger setting of a 7D20 Programmable Digitizer:

```
INPUT #22 PROMPT "TRIG?":TRSET$.
```

The statement starts by asking: "What are your trigger settings?" The instrument answers by getting the settings and putting them onto the bus as a message: TRSET$. The Input statement is the means of receiving the message and storing it in string variable TRSET$. When a string variable (variable name followed by $) is used with the Input statement, the entire message is stored in the variable.

Perhaps you are interested in all the control settings of an instrument. SET?, a universal query for all Tektronix *Standard Codes and Formats* instruments, causes the queried instrument to send a message that lists all of its current settings. This entire settings message can then be stored in a string variable. You can acquire and store a number of instrument configurations in different string variables. Then, just by sending the appropriate string variable to an instrument, the instrument can be reset at any time to any of the stored configurations. (Since the settings message can be several hundred characters long, it may be necessary with some software packages to extend or dimension the string variable to a length capable of holding the message.)

In essence, SET? is a "learn mode" of operation. It allows your software to "memorize" instrument setups for later use. If you would like to experiment with this, set your instrument to a familiar measurement configuration. Using 4041 BASIC, enter the following statements (20 is assumed here to be the address of a 7D20 Programmable Digitizer and SET$ is dimensioned to a length of 300 characters to be sure to accommodate all of the instrument's settings):

```
DIM SET$ TO 700
INPUT #20 PROMPT "SET?":SET$
```

Now change several of the control settings. Then enter the following statement:

```
PRINT #20:SET$
```

The instrument will switch its control settings back to those stored in SET$.

To see what is in SET$, just enter PRINT SET$. The entire settings message will be printed out on the terminal screen for your inspection.

Each Tektronix programmable instrument responds to a variety of queries, each query consisting of a keyword specific to the information desired. If you would like to know what measurement function your DM 5010 Programmable Digital Multimeter is set up for, just send it "FUNC?". The DM 5010 will prepare to send back DCV, OHMS, DIODE, ACV, or ACDCV and the measurement range the function is set for. Send the same query to your FG 5010 Programmable 20 MHz Function Generator, and it will prepare to send back FUNC SINE, FUNC SQUARE, OR FUNC TRIANGLE, depending on the waveform it is generating; another example of how Tektronix *Standard Codes and Formats* instruments work with you in plain English.

NEW

SOFTWARE AND DOCUMENTATION

Instrumentation Software Library

The Tektronix Instrumentation Software Library provides software and application information to aid in the design and implementation of measurement solutions using Tektronix programmable instruments. In addition to Utility Software described in detail below, the library contains Application Software and User Software. Application Software provides a complete solution to a measurement problem using Tektronix programmable measurement instruments or systems. Application Software is ready to run and requires little or no software integration or modification by the user. User Software is developed by users to perform specific measurements or functions with Tektronix programmable instruments or systems. Application Software, Utility Software, and selected User Software are available on tape media. Other user software is available as printed listings only.

The Tektronix Instrumentation Software Library Catalog contains abstracts and ordering information for available programs. For a copy of the latest catalog, ask your Tektronix Sales Representative for Tektronix literature number 45W-5293.

Utility Software

As part of our continuing support program for users of GPIB test equipment, Tektronix now offers software tools in the form of Utility Software. Utility Software is a set of instrument utilities designed to perform a variety of functions on specific GPIB instrument/controller combinations. The present offering includes utility software for the 7D20 and 7D20T Programmable Digitizers, the Sony/Tek 390AD Digitizer, and the entire TM 5000 line of programmable instrumentation products. This utility software is available for the Tektronix 4041 System Controller and the Tektronix 4052A Graphic Desktop Computer.

Utility software is designed to significantly ease the task of creating test and measurement software, historically one of the most expensive tasks in solving a measurement problem with an automated system. Each utility routine is designed as a BASIC subprogram which is easily transferred to your measurement programs and called by a single BASIC statement. These subprograms eliminate the need to design, write, and debug program segments to perform the most-used utility functions between controllers and instruments. This can save you considerable time and expense.

Instrument Interfacing Guides

As a system integration aid, Tektronix provides Instrument Interfacing Guides for selected GPIB instruments. These guides aid the user in configuring, connecting, and getting the instrument operating with a controller as quickly as possible. They contain specific information on the GPIB operation of the instrument. Designed to supplement the operator's manual, they are supplied free of charge with the instrument, or are available separately. See your Tektronix Sales Representative for details on these interfacing guides.

Controller Programming Guides

As an additional aid in GPIB system integration, Controller Programming Guides are supplied with each 4041 System Controller and 4052A Graphic Desktop Computer. These programming guides supply specific information and guidelines on the controller's GPIB operation capability, as well as suggestions for getting the best performance from your controller/instrument combination. Sample programs are used to demonstrate all aspects of GPIB operation and processing power of the controller.

Programmable Instruments Newsletter

HANDSHAKE is an applications newsletter for signal processing and programmable instrument control. Published quarterly, it contains technical articles on measurement processes, techniques, and instruments. HANDSHAKE is offered free.

Other Support

Each Tektronix programmable instrument and system is supplied with complete user and maintenance manuals. Operator and maintenance training is also available to help you get the most out of your instruments or systems.

System Support—The Added Value

This combination of utility software, instrument interfacing guides, and controller programming guides is a definite value in solving your measurement problems with a system of Tektronix programmable instruments, and demonstrates the continuing support Tektronix provides for its products.

ORDERING INFORMATION

UTILITY SOFTWARE

7D20/7D20T/4041 Utility Software

Provides 7D20 Programmable Digitizer utilities for use on the 4041 System Controller. Includes subprograms to transfer waveforms from the 7D20 to the controller, transfer waveforms to the 7D20, store waveform data and retrieve it from the 4041's tape storage, plot waveform data on a graphics terminal, and other useful instrument utilities. Desired utility subprograms can be appended to your 4041 BASIC measurement program. Supplied on DC 100 tape media.

Order 062-6959-01 ..... $150

7D20/7D20T/4052A Utility Software

Provides the same capabilities as 062-6959-01 above to operate the 7D20 Programmable Digitizer with a 4052A Graphic Desktop Computer. Supplied on DC 300 tape media.

Order 062-6961-01 ..... $150

390AD/4041 Utility Software

Provides 390AD Programmable Digitizer utilities for use on the 4041 System Controller. Includes subprograms to transfer waveforms to and from the 390AD, plot waveform data on a graphics terminal, and other useful instrument utilities. Desired utility subprograms can be appended to your 4041 BASIC measurement program. Supplied on DC 100 tape media.

Order 062-6956-01 ..... $150

390AD/4052A Utility Software

Provides the same capabilities as 062-6956-01 above to operate the 390AD Programmable Digitizer with a 4052A Graphic Desktop Computer. Supplied on DC 300 tape media.

Order 062-6960-01 ..... $150

TM 5000/4041 Utility Software

Provides utilities for the entire TM 5000 line of GPIB measurement products to operate with a 4041 System Controller. Includes subprograms to acquire peak-to-peak values from programmable digital counters, supply status and error code messages, and other useful instrument and programmable function card routines. Supplied on DC 100 tape media.

Order 062-6958-01 ..... $150

TM 5000/4052A Utility Software

Provides the same capabilities as 062-6958-01 above to operate TM 5000 GPIB measurement products with a 4052A Graphic Desktop Computer. Supplied on DC 300 tape media.

Order 062-6957-01 ..... $150

For information on other measurement instrument software available from Tektronix, contact your Tektronix Sales Representative.

A Controller to Match Your Instrumentation System Needs

The one common element that binds both large and small instrumentation systems together is the system controller. Tektronix offers a number of IEEE-488 controllers to fit your system needs. The system, or instrument controller, is in reality just a computer that has been designed to optimize the interaction and communication between the controller and a wide variety of programmable instruments and peripherals. This interaction is enhanced by instrument control commands in a high-level programming language such as BASIC, eliminating the need for the user to understand the IEEE-488 interface protocol in detail. The user only needs to supply the instrument address and the function to be performed. The controller automatically takes care of the rest—interface handshaking, bus states and transitions, etc.

The ideal controller for a particular use depends upon the specific requirements of the application. Such varied applications as laboratory automation, manufacturing test, QA/QC, service/repair, and environmental data acquisition/analysis each have unique controller requirements. Some applications require little or no operator interaction and perform repetitive tasks over and over again. For these cases, a tamper-proof execute-only controller capable of running unattended with little or no display requirements is often very desirable.

The other end of the application spectrum may require a large amount of operator interaction for developing programs, providing operator prompts and instructions, reviewing intermediate or final test results, and making changes in the test setup based upon test results. Where graphics are helpful as an analysis tool, a controller with an integrated display screen may be the best choice.

Expandability and flexibility is another important consideration in choosing an instrument controller. For example, controllers without an integral CRT for display allow you to select the exact display features which best suit the requirements of the application. For program development, a low-cost alphanumeric-only terminal may be best. However, for interactive applications or data analysis and interpretation, a graphics terminal, perhaps with color, would be a better choice. This ability to choose screen size, resolution, number of lines, color, and other display parameters greatly enhances the controller's capability.

Likewise, the ability to add memory, program ROMs, system peripherals, etc., greatly enhances a system controller's capabilities. This expandability will allow you to reconfigure your system to meet future measurement needs as applications change.

Whatever your current or future instrumentation system needs, Tektronix controllers provide a choice to allow systems to be configured with the right operator interface, memory, display, hardware interfaces, and peripheral support.

GPIB IEEE-488

4041 System Controller

The 4041 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

Easy to Use Extended BASIC with Local/Global Variable Definition

32 Kbytes Memory Standard — Expandable to 160 Kbytes

Four New ROM Packs to Enhance the 4041 for PROM File Creation, Special Graphics, and Signal Processing Capability

Easily Configured for Any Implementation of the IEEE Standard 488

Execute Only Mode for Program Security

Detachable Keyboard (Option)

Modular Design — Rackmount or Portable

The 4041 Controller is a powerful, flexible, expandable IEEE Standard 488 (GPIB) systems controller designed to work with Tektronix and other vendor's IEEE Standard 488 instruments. While the basic unit is intended principally for execute only environments such as production line testing, a variety of options and peripherals are available to equip the 4041 for full interactive flexibility. Tektronix' full line of terminals (graphics or alphanumeric, storage or raster, and color) are completely compatible to create an optimum programmer interface in the more sophisticated areas. Software features similarly span the range from the occasional programmer to the sophisticated programming team tackling complex applications. The basic 4041 permits very compact system configurations that go into applications impractical for earlier generations of systems.

4041 Architecture

The 4041 Controller contains three microprocessors. The CPU is the powerful 16-bit 68000. Standard memory is 32 kbytes with optional expansion to a maximum of 160 kbytes. A 20-character alphanumeric LED display, a 20-character thermal printer, a DC 100 cartridge drive, 18 key-numeric/function keypad, a GPIB port, an RS-232 port, and a real-time clock and calendar capability are all standard. An additional GPIB/RS-232 port pair is optional, with the second GPIB port having DMA (Direct Memory Access) capability, which allows you to separate the slow instruments on one port and the fast instruments on the DMA port for best possible throughput.

The standard 4041 BASIC can be expanded by installing ROM (Read-Only Memory) packs to extend operational features of the 4041 into a broad range of systems applications.

Option 01 adds a second pair of ports (one IEEE Standard 488 and one RS-232). The Option 01 IEEE Standard 488 port has DMA capability. Other options include an 8-bit parallel TTL port (Option 02), the program development ROMs and carrier (Option 30), and a program development/debug keyboard (Option 31). Options 30 and 31 could thus let a test engineer easily and temporarily convert an installed execute-only 4041 into a debug/edit mode, make necessary program changes, and restore it to the tamper-proof condition. Extensive program development, however, would normally be accomplished at a programming station consisting of an Option 30 4041 plus a CRT terminal to permit multi-line viewing of program listings.

The 404l package is a compact monolithic unit of identical height and width to the TM 5003 Power Module. A 4041 and TM 5003 can be easily fastened together and used on the bench or rackmounted as a single unit, leading to extremely compact system configurations suitable for crowded benches and racks or use in vans, ships and aircraft.

Language Enhancements

BASIC is an excellent language for the occasional programmer, and was chosen for the 4041. Its English-like commands, simple syntax, and line-by-line interpreter implementation combine for friendly, easy use. To improve the self-documenting characteristics and reduce maintenance costs, 4041 BASIC is enhanced by several features. Variable names may be up to eight characters, allowing the programmer to select meaningful names like Risetime, Voltage1, or Delay. Subprograms and program lines may be named, with examples such as SRQHANDL or CALCRMS.

Traditional BASIC leaves much to be desired for most sophisticated programmers, however, 4041 BASIC includes many enhancements such as FORTRAN-like subprograms. Variable passing from main to subprograms and the ability to declare any variables as local or global means that a team of programmers can work quite independently on a massive task, with the main program ultimately being not much more than a series of subprogram Call statements. Other powerful features include optional data types (short and long floating point plus integer), a Compress command to optimize memory use, a proceed mode which overlaps I/O and processing operations for maximum system speed, logical unit assignment capability, and up to 160 kbytes of memory directly addressable without overlays or paging techniques.

New ROM Packs

The 4041R01 Graphics ROM pack gives the 4041 the capability to generate graphic commands to interact with peripheral devices using Tektronix compatible graphic codes. These high-level and primitive commands allow you to construct and incorporate graphic images, symbols, charts and diagrams into your system's application.

The 4041R02 Plotting ROM Pack gives the 4041 the capacity to generate graphs and to plot data with very little programming knowledge needed. Designed as an easy-to-use tool to automatically generate scientific graphics, the Plotting ROM pack requires the presence of the 4041R01 Graphics ROM Pack to operate. The automatic plotting commands are the heart of the 4041R02. These commands, given your data, draw axes with appropriate tic marks and plot the desired data. You need little experience to program graphics or plotting routines, all you need to do is supply the data to be graphed.

The 4041R03 Signal Processing ROM Pack gives the 4041 the ability to support instrumentation system applications requiring waveform processing. Coupled with our programmable digitizers and oscilloscopes, it will produce broader system configurations and effective solutions for signal analysis.The functions contained in the 4041R03 provide a high-level approach to deal with signal processing applications normally solved by lengthy programming requiring extensive knowledge of waveform processing and computer fundamentals. Combined with the graphics and plotting ROM packs, the 4041R03 allows you to produce, analyze and display waveforms semiautomatically.

The 4041R04 Utility ROM Pack adds still more general-purpose capabilities to your 4041 System Controller. These range from such convenience items as one-line descriptions of error codes to capabilities for building PROM files for programming your own EPROMs.

The 4041R04 gives you the ability to have English error messages printed, interval/time of day Timer devices (allows complex interrupt capability at time of day or after specified number of seconds), a Soft ROM pack loader function, and the capability of being able to put often used programs into EPROM. The accessory PROM builder kit allows you to develop the EPROMs to use with the PROM file system. PROM files are built using the "PRMBLD" program, which creates a ROM image of the program that can be saved on the DC 100 tape. Once the image is saved, it can be transferred over one of the 4041's interfaces to your PROM programmer using "RMXFER".

Test and Measurement Orientation

The 4041 Controller was developed simultaneously with the TM 5000 instrument family, and optimized as an instrument controller. Many of the IEEE Standard 488 functions are simple high level commands in 4041 BASIC. Examples include ATN, GET, LLO, and several others. In its power-up default condition, the 4041 implements Tektronix *Standard Codes and Formats* and thus can communicate instantly with Tektronix IEEE Standard 488 instruments without any programmer attention to formats, syntax, delimiters, number format, etc. However, the 4041 also has virtually complete, programmable control over every IEEE Standard 488 line and condition. When this ability is combined with the 4041's Logical Unit assignment and stream specification ability, virtually any IEEE Standard 488 instrument or device can be easily handled. The stream specification ability means that a particular device's format, syntax, end-of-message character, and other idiosyncrasies can be described one time in a Logical Unit assignment statement. Thereafter, the programmer can control or obtain data from that instrument as easily as from an instrument that fully complies with Tektronix *Standard Codes and Formats*.

The error trapping and handling capabilities of the 4041 are of particular importance in test and measurement systems. Virtually any category of error—in instruments, peripherals, on the bus or even within the 4041—can be trapped and handled by software drivers. When coupled to the powerful self-diagnostics and error reporting features of TM 5000 instruments, very fault-tolerant systems can be configured which demand little or no operator skill.

CHARACTERISTICS

FRONT PANEL KEYBOARD

SYSTEM KEYS

Auto-Load — Causes the internal magnetic tape to rewind and find the "AUTOLD" program. This program is then loaded into memory and execution begins.

Abort — Halts program execution if no user-specified handler routine is called by the program. If a handler routine is specified for the Abort key, program control is passed to that routine.

Proceed — Performs one of the following functions depending on equipment or program state:

1. Causes program execution to start at the next program line if a Pause was encountered.

2. Resumes execution after an Abort. If a program is loaded from the tape, execution starts from the first program line.

3. Delimits user input when requested from an Input statement.

Clear — Clears the alphanumeric display. Does not clear user-defined prompts or the input cursor from an Input statement.

Eex — Causes the number requested by an Input statement to be entered in scientific notation. Numbers entered after pressing the EEX (Enter Exponent) key are considered part of the exponent.

Pause — Halts the program after executing the current line. If the current program line is an Input statement, the program stops before the execution of Input.

USER-DEFINABLE FUNCTION KEYS

Numeric user-definable function keys, 0-9, can be assigned subroutines by the applications program. The keys may be redefined by the program during execution to allow for unlimited user routines. The function keys can be enabled or disabled under the control of a program.

Numeric values are assigned to these keys for entering information requested by an Input statement. When input has been completed, user functions assigned to these keys are re-enabled.

The other two keys on the front-panel keyboard are the decimal key (".") and the minus ("–") key. The decimal key is provided for decimal point entry associated with numeric and the minus key is used to enter negative numbers associated with numeric.

Keyboard overlays may be used for labeling the function keys with a number or an abbreviation of the user routines.

FRONT-PANEL DISPLAY

The front-panel display communicates test procedures and operator prompts and displays intermediate or final program results. The display is fully programmable.

ALPHANUMERIC DISPLAY

Alphanumeric Line — Twenty characters.

LED — Sixteen segments.

Size — Height: 3.8 mm (0.15 in). Width: 2.8 mm (0.11 in).

Characters Per Cm — 1.6 characters/cm (4 characters/in).

Character Symbols — Sixty-four.

Message Viewing Time — Programmable.

Scrolling Rate — Programmable.

SYSTEM INDICATORS

Leds — Located on the display front panel indicate the status of the system.

Busy — Indicates that a program is running. A blinking Busy light indicates that the system has Paused (temporarily halted).

Power — Indicates the machine is on.

I/O — Indicates that an Input/Output operation is being performed.

FN — Indicates that the user-definable function keys are enabled.

MAGNETIC TAPE DRIVE

Magnetic tape drive is used to store user's programs and data. The tape is the primary means of loading programs, particularly for execute-only applications; in addition, the tape drive provides for long-term unattended data logging.

File Structure — 48 named files (maximum).

Capacity (Physical Records) — 650 typical (600 minimum).

Physical Record — 256 bytes.

Average Transfer Rate — 10.24 kbits/s.

Search Speed — 1520 mm/s (60 in/s).

Tape Rewind — 1520 mm/s (60 in/s).

Tape Cartridge — 100A Certified Data Cartridge fromTektronix.

PRINTER

The printer produces hard copies of the intermediate or final program results, operator prompts, and changes in variables or system status. Messages longer than 20 characters are printed on succeeding lines where the user can specify the appropriate indentation for better delineation and readability.

Printing Method — Thermal, fixed head.

Capacity — 20-character alphanumeric line.

Font — 5 x 7 dot matrix printed.

Character Size — 2.5 mm high x 1.8 mm wide (0.10 in high x 0.07 in wide).

Line Spacing — 6 ±½ lines/in.

Printing Speed — 2.0 ±0.24 lines/s.

Feed Speed — 8.46 mm/s (0.34 in/s).

Character Set —
26 Uppercase letters
26 Lowercase letters
10 Numeric digits
34 Special characters
32 Control characters
128 Total

Paper Size — 60 mm x 25 m (2.36 in x 82 ft).

CONTROLLING THE BUS

The 4041 automatically controls all bus management signals in the proper sequence for the desired interface task and instrument interaction. Bus management functions use direct IEEE Standard 488 mnemonic commands to accommodate differences in implementation of GPIB on other equipment. Virtually all legal bus states can be programmed this way, which affords a high degree of flexibility for addressing various system applications.

BUS INTERRUPTS

The 4041 has the ability to detect and respond to various types of interrupt conditions that can be generated on the GPIB. User-specified software handlers can be written to perform various tasks when these conditions occur. Interrupts can be programmably ENABLED or DISABLED.

Interrupt Conditions

Mnemonic	Message
SRQ	Service Request
EOI	End or Identify
IFC	Interface Clear
DCL	Device Clear
TCT	Take Control
MTA	My Talk Address
MLA	My Listen Address

BUS COMMUNICATION

Interface and bus device addressing are programmable. This allows the user to direct message and data flow to and/or from the appropriate interface and GPIB peripheral. Information such as primary and secondary addressing, along with pertinent device-dependent information, can be attached to a specific Logical Unit number. Subsequent communication with that GPIB device can be directed to the Logical Unit, eliminating the need for redundant or repetitious statement programing.

TRANSFER RATES (IEEE STANDARD 488)

Transfer Rates for the Standard Interface

	Input	Output
Normal Mode	Exceeds 5 kbytes/s	Exceeds 5 kbytes/s
Fast Mode	Exceeds 16.5 kbytes/s	Exceeds 19.5 kbytes/s

SERIAL INTERFACE

The 4041 comes with a standard serial asynchronous RS-232C interface. The 4041 can support applications requiring terminals, modem/host communication, or instrumentation with this interface protocol.

In addition to standard transmission rates from 75 to 9600 baud, transmission rates are programmable to any integer ranging from 2 to 9600 baud.

Full Duplex — Full capability (half duplex not supported).

Transmit/Receive — Matched rate only.

Bits Per Character — 5, 6, 7, or 8 bits.

Stop Bits — 1 or 2.

Parity — Even, Odd, High, Low, None.

ERROR AND INTERRUPTS

Conditions such as parity, framing and overrun errors receipt of data or data available, and Break can all be programmably captured. User routines or handlers can then direct what action should be taken, depending on the particular condition.

The end of message delimiter (EOM) can be programmed to any one or two character ASCII string. This enables the 4041 to communicate with most hosts or peripherals via the serial interface, or GPIB interface.

CLOCK/TIMER

One clock provides date and time of day which is programmably set. The timer clock returns the time in seconds since power up. The timer has 10 millisecond resolution.

SELF-TEST

An integral part of the 4041 is the self-test feature, which assures the user of reliable operation. Self-test is executed automatically on power-up and performs extensive hardware and operating system tests.

SYSTEM VERIFICATION

The system verification tape is a standard accessory that tests 4041 components not covered by the self-test. These include front panel controls and indicators, and the optional program development keyboard interface line drivers can be tested. If necessary, by connecting loopback connectors.

DYNAMIC RANGE

Short Floating Point — Maximum ±3.40282 E±38; Minimum ±2.93874 E±39.

Long Floating Point — Maximum ±1.7976931348623 E+308; Minimum ±5.562684646269 E−309.

Integer — ±32768 to ±32767.

Character String Length (Maximum) — 32767.

Array Elements (Real, Integer or Character Arrays) — 32767 elements maximum per row (or column); limited by total memory installed.

AC POWER REQUIREMENTS

Line Voltage — 90 to 132 V ac and 180 to 250 V ac.
Line Frequency — 48 to 66 Hz.
Power Consumption — 120 W (maximum).

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature — Without Data Cartridge or Printer Paper: 0°C to −55°C. With Data Cartridge or Printer Paper: 0°C to −45°C.
Storage Temperature — Without Data Cartridge or Printer Paper: −40°C to −75°C.
Humidity — Without Data Cartridge or Printer Paper: 95%. With Data Cartridge or Printer Paper: 85%. Nonoperating: 95%.
Altitude — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).
EMI — Meets FCC Part 15, Subpart J, Class A and VDE 0871 Class B.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	216	8.5
Height	180	7.2
Depth	527	20.8
Weights	**kg**	**lb**
Net	7.8	17.5
Net (with options)	8.8	19.5

INCLUDED ACCESSORIES

Power cord (161-0066-00); blank overlays for FP keyboard (334-4074-00); system verification tape (062-5828-00); blank DC 100 Tape Cartridge (119-1350-00); RS-232 male loop back connector (013-0198-00); roll of printer paper (006-3557-00); instruction manual.

ORDERING INFORMATION

4041 System Controller **$4,995**

Option 01 — Second GPIB and RS-232C ..... **+$1,600**
Option 02 — TTL Interface 8 Bit Parallel Interface .... **+$800**
Option 20 — Added Memory 64 Kbyte Total ..... **+$1,300**
Option 21 — Added Memory 96 Kbyte Total ..... **+$1,800**
Option 22 — Added Memory 128 Kbyte Total ..... **+$2,250**
Option 23 — Added Memory 160 Kbyte Total ..... **+$2,650**
Option 30 — Program Development ROMs and ROM Carrier ..... **+$995**
Option 31 — Program Development Keyboard ..... **+$550**

RACKMOUNTABLE KIT

Cabinet-to-Rackmount Conversion Kit — Equipped with slide-out assembly to rackmount a 4041 Instrument Controller to the left of a TM 5003. Order 040-0984-00 ..... **$190**

ROM PACKS

4041R01 — Graphics ROM Pack **$495**
4041R02 — Plotting ROM Pack **$495**
4041R03 — Signal Processing ROM Pack **$795**
4041R04 — Utility ROM Pack **$295**
Accessory Package Kit — For 4041R04. Order 020-0102-00 ..... **$145**
EPROM Kit — For 4041R04. Order 020-0101-00 ..... **$50**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz

FIELD INSTALLED MODIFICATIONS

4041F01 ..... **$1,800**
4041F02 ..... **$1,000**
4041F30 ..... **$995**
4041F31 ..... **$550**
First Expansion from standard configuration (32 kbytes for total of 64 kbytes). Order 040-1021-00 ..... **$1,500**
Memory Expansion of 32 kbyte increments above 64 kbyte total. Order 040-1022-00 ..... **$600**

OPTIONAL ACCESSORIES

ROM Carrier — Order 013-0215-00 ..... **$150**

GPIB IEEE-488 4052A System Controller

- 11 Inch DVST Display
- Graphic Enhanced BASIC
- Mainframe Memory Expandable to 64 k
- Extended Memory File Manager to 512 Kbytes
- High Speed 16-Bit, Bit-Sliced Processor
- GPIB and RS-232C Compatible

GPIB IEEE-488 4054A System Controller

- 19 Inch DVST Display
- Enhanced High Resolution Graphics
- Dynamic Graphics Option
- Thumbwheel Controlled Crosshair Cursor
- Mainframe Memory Expandable to 64 k
- Extended Memory File Manager to 512 Kbytes
- GPIB and RS-232C Compatible

See page 130 for full description of 4054A GPIB System Controller.

ROM PACKS

GPIB Enhancement ROM Pack

Improves the performance of the 4052A and 4054A as instrument controllers using thirty-nine commands; twelve to facilitate standard GPIB commands using direct call statements; twelve to improve GPIB polling by adding parallel polling, control of SRQ sensing, automatic serial polling and decoding of *Tektronix Codes and Formats* for standard error messages. Fifteen additional commands expand binary data acquisition and automated data manipulation.
Order 4052R14 ..... **$495**

Signal Processing ROM Pack #1

Adds seven new functions which can be applied to one dimensional data arrays; integration, differentiation (2 and 3 point), fast graphing, locating minimum and maximum, and crossing over a threshold. Functions operate 2 to 10 times faster than equivalent BASIC routines.
Order 4052R07 ..... **$250**

Signal Processing ROM Pack #2

Extends array handling capabilities by adding commands that perform Fast Fourier Transform (FFT), its inverse (IFT), convolution, correlation, windowing and related utility functions. Functions execute 7 to 20 times faster than BASIC routines.
Order 4052R08 ..... **$495**

Extended Memory File Manager

Integrated-RAM-based peripheral with command structure similiar to 4907. Provides storage of data files and programs with high speed transfers.
Order 4052F27 256 Kbytes **$2,500**
Order 4052F28 512 Kbytes **$3,300**

ROM Expander

Permits connecting up to eight ROM Packs to the 4052A or 4054A. Series desktop computer. Utilizes one slot of existing two slot backpack.
Order 4050E01 ..... **$800**

NEW 4105 Color Display Terminal

- Low-Cost, High Quality Color Graphics and Alphanumerics
- Addressable Display Matrix of 4096 by 4096 Points
- Select 8 Colors from a Palette of 64
- Protected Fields
- Compatible with 4691 and 4695 Color Graphics Copiers

See page 98.

4025A Display Terminal

- Alphanumerics and Graphics
- ASCII Character Set and Finger Tip Editing
- Enhanced, Blinking, Inverted and Underlined Fields
- Protected Fields
- 16 User-Definable Keys
- Learn Mode
- Video Hard-Copy Output

See page 127.

4932 GPIB Extender

- Extends GPIB Communications Up to 500 m
- User Transparent Operation
- Especially Designed for Use with 4909 System

See page 132.

NEW 4691 Color Graphics Copier

- High Image Quality and Excellent Color Saturation
- Adjustable to A & B Size
- 125 Color Shades
- Clear Transparency Capability
- Landscape and Portrait Formats
- Four-Way Multiplexer Option

See page 103.

4611 Hard-Copy Unit

- Low Copy Cost
- High Contrast, Permanent Images
- Electrostatic Process
- Compatible with 4025A

See page 133.

4643 Printer

- Fast, High-Quality Matrix Printing
- Easy to Use
- International Characters
- Fan-Fold, Tractor Feed

See page 135.

4662 Multi-Color Digital Plotter

- Intelligent B-Size Plotter
- Built-In RS-232 and GPIB Interface
- No Hysteresis or Drift

See page 137.

4907 File Manager

- Flexible Disc, Double Density
- Up to Three Discs, 630 kbytes/Disc
- 4050 Series Compatible
- Built-In File Manager
- Advanced Multiple Level, File-By-Name System

See page 131.

4909 Multi-User File Management System

- Shared Access Up to 10 Users
- 32 Mb to 96 Mb Capacity
- Expandable to 768 Mb
- Variable Length Records
- Concatenated Volumes
- English Command Operation Over High-Speed GPIB

See page 132.

DIGITIZERS

CONTENTS

7D20/7D20T Programmable Digitizers 337
7854 Waveform Processing Oscilloscope ... 340
390AD Programmable Waveform Digitizer . 342
7612D Programmable Waveform Digitizer .. 344
7A16P Programmable Amplifier 345
7912AD Programmable Waveform Digitizer .346
7B90P Programmable Time Base 347
5223 Digital Storage Oscilloscope 348
468/R468 Portable Digital Storage Oscilloscope 350
336 Portable Digital Storage Oscilloscope .. 352

IEEE STANDARD 488 COMPATIBLE

Especially designed for precise automatic waveform measurements in demanding applications in R&D and production environments.

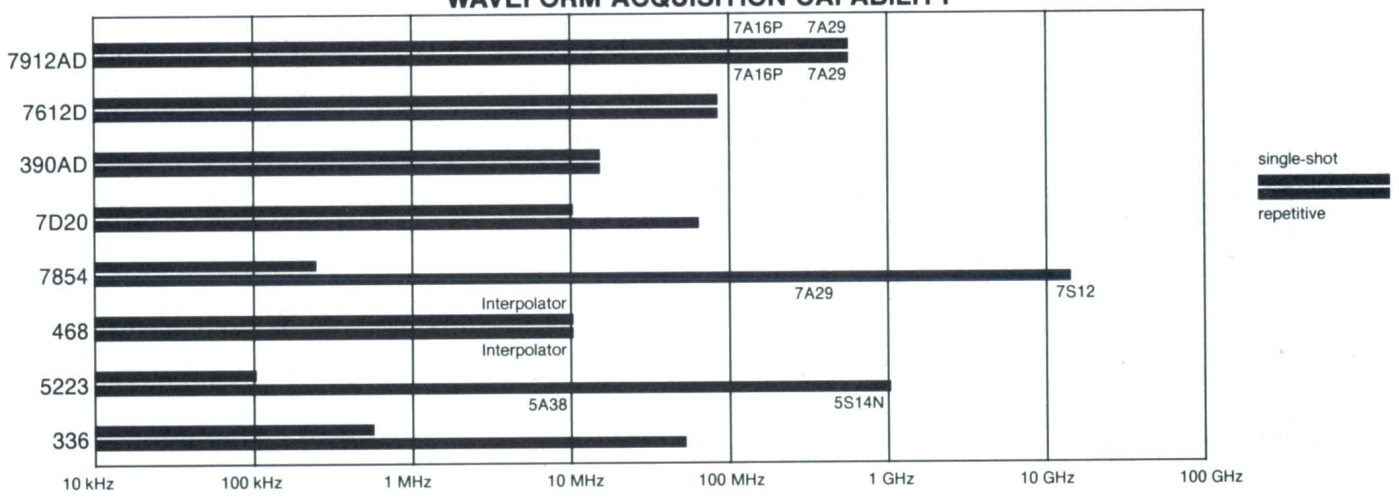
DIGITAL OSCILLOSCOPES AND WAVEFORM DIGITIZERS

Type	Analog Digitizing BW	Maximum Digitizing Rate	Vertical Resolution	Data Words Per Waveform	Maximum Stored Waveforms	Useful*1 Storage BW (SS)	Equiv*2 Storage BW (rep)
390AD	15 MHz	30 MHz dual channel 60 MHz CH 1	10 Bits	2048 dual channel 4096 CH 1 only	2	15 MHz	15 MHz
336	50 MHz	1 MHz	8 Bits	1024 each channel	2 (16 with Option)	140 kHz	50 MHz
7854	400 MHz	500 kHz Ext Clock	10 Bits	Up to 1024	Up to 40	50 kHz	400 MHz
468	100 MHz	25 MHz	8 Bits	512 in Alt 256 in chop	4	10 MHz	—
5223	10 MHz	1 MHz	10 Bits	1024/plug-in	4	100 kHz	10 MHz
7912AD	500 MHz	100 GHz	9 Bits	512	1	500 MHz	500 MHz
7612D	90 MHz	200 MHz	8 Bits	Up to 2048	Up to 16	80 MHz	80 MHz
7D20/ 7D20T	70 MHz	40 MHz	8 Bits	Up to 1024	6	10 MHz	70 MHz

*1 *Useful Storage Bandwidth is a measure of the highest frequency sinewave that can be stored in a single sweep and displayed in a visually useful manner. This is dependent on both the maximum digitizing rate as well as the display reconstruction technique used.*

*2 *Equivalent Storage Bandwidth indicates the highest frequency repetitive signal that can be stored and displayed with less than 3 dB loss of signal amplitude using equivalent time digitizing techniques.*

WAVEFORM ACQUISITION CAPABILITY



This section brings together high performance digitizing mainframes, stand-alone digitizers and portable digital storage oscilloscopes suited to today's demanding measurement needs.

The high performance digitizing mainframes offer a wide choice of performance capabilities. Depending on the mainframe, capture high or low speed signals that are repetitive or single shot. Configure mainframes to your individual needs from a choice of a score of plug-ins. The 7854 combines outstanding analog and digital performance with microprocessor-based waveform processing whereas the 7612D and 7912AD combine outstanding analog and digital performance with full programmability. The ***NEW*** 7D20T incorporates a 7D20 into its own power module but without a display. The 7D20T is the ideal high performance digitizer in automated systems applications where visual display of the acquired signals is not required.

Adjunct to the 7000 Series digitizing mainframes is the SONY/TEKTRONIX 390AD which features dual-channel and dual-time-base operation.

The ***NEW*** 336 displays both analog and digitized waveforms simultaneously and can store up to 16 digitized waveforms for recall and display. It is microprocessor controlled and incorporates alphanumeric CRT readouts of the scale factors and cursor positions.

The 5223 Digitizing Oscilloscope is capable of displaying real time and stored waveforms simultaneously. The 5223 accesses the digital storage functions by using the 5B25N Time Base.

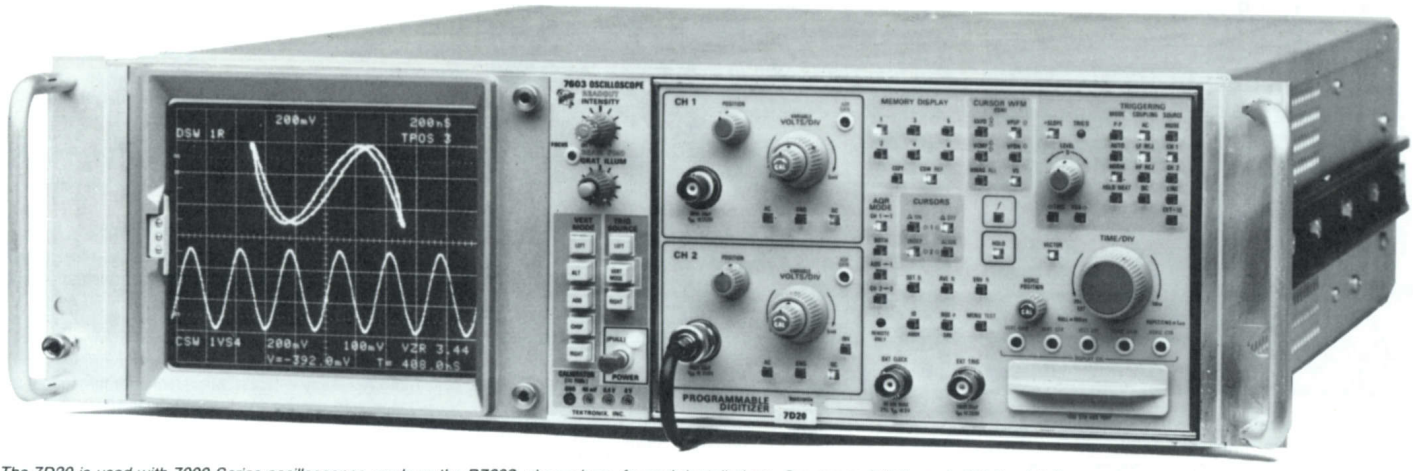
The high performance 468 Portable Oscilloscope has unlimited storage time; expandable, repositionable stored traces; Save Reference memory; pretrigger viewing; and correction for the trigger uncertainty. These factors, inherent in digital storage, make the 468 the most versatile digital storage scope available.

Digital Storage

Digital storage requires digitizing and reconstruction processes. "Digitizing" consists of "sampling" and "quantizing." Sampling is the process of obtaining the value of an input signal at discrete points in time; quantizing is the transformation of that value into a binary number by the analog-to-digital converter (ADC) in the digital scope. You determine how often digitizing occurs by the time base. The time base uses a digital clock to time the analog-to-digital (A/D) conversion and to store the data in memory. The rate at which this happens is the digitizing rate (or sampling rate).

Once the data is in the digital memory, it can be read out and reconstructed for displaying or further waveform processing.

NEW



The 7D20 is used with 7000 Series oscilloscopes, such as the R7603, shown here, for rack installations. See pages 246 through 254 for details.

GPIB IEEE-488

7D20 *NEW* 7D20T

The 7D20 and 7D20T comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Digital Storage for 7000 Series Mainframe (7D20)

70 MHz Bandwidth for Repetitive Signals

10 MHz Single-Shot Bandwidth

Two Channels Simultaneous Acquisition

Totally Programmable

Storage of Six Independent Waveforms

Enveloping and Signal Averaging

Cursor Measurements

Pretrigger and Posttrigger

APPLICATIONS

- **Ultrasonics**
- **Digital Design**
- **RF Modulation**
- **Automated Production Testing**

The 7D20 brings state-of-the-art digital performance to Tektronix 7000 Series mainframes and rackmounts.

The 7D20 is a GPIB programmable plug-in that is compatible with all 7000 Series mainframes (including the USM 281C) except the 7104. When combined with a 7000 Series mainframe, this plug-in creates a fully programmable, digitizing oscilloscope.

The 7D20T is the ideal high performance digitizer in automated systems applications where visual display of the acquired signals is not required. The 7D20T is supplied with its own power module, but without a display. Rear panel connectors provide X, Y, and Z output data for use with an external X-Y monitor, if desired.

Four feedthrough cables permit routing of input/output signals from the front panel of the 7D20T to the rear in rack-mounted applications. The GPIB cable may be connected to either the front or the rear of the 7D20T.

The capabilities and characteristics described here for the 7D20 also apply to the 7D20T.

For those users who already own a 7D20 and would like to convert this 7000 Series plug-in into the 7D20T configuration, the power module itself is available as a 7D20T Option 01.

The 7D20/7D20T can accurately measure the amplitude of a 50 ns wide transient event. Dual samplers simultaneously acquire two channels as if it were a "dual-beam" scope.

Beyond basic acquisition, the 7D20/7D20T offers signal averaging to reduce uncorrelated noise, envelope displays to compare dynamic characteristics of changing signals, pretrigger for viewing prior to the trigger event, storage of six independent waveforms plus a reference waveform, cursors for more accurate two-dot measurements, and user prompting and menu displays to improve user interface effectiveness.

Digital Storage

A 40 MHz maximum sampling rate provides approximately 10 MHz single-shot bandwidth and up to 70 MHz bandwidth with repetitive signals.

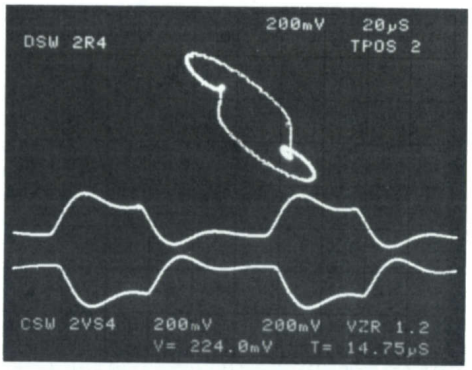
Storage and Recall Front Panel Settings

Up to six different front panel set-ups can be stored and recalled as desired. These settings, plus the last panel setup, are saved in nonvolatile memory and are restored automatically when power is applied.

Fully Automated Measurements

Since the 7D20/7D20T is completely programmable, fully automated measurement and testing is possible. Tektronix programmable signal sources, multi- function interface, and RF scanner provide and control the test signals while the 7D20/7D20T acquires waveforms for the computer or controller.

X-Y Waveform Display and Time Reference

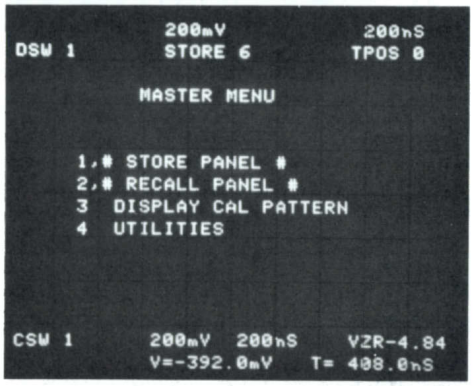


Unique display capability allows viewing Y versus X events and Y versus time simultaneously. X-Y channels are matched at 10 MHz with <2° of phase shift.

Cursor Measurements

Accurate amplitude measurements (referenced to ground) and time measurements (referenced to trigger position) are made using one cursor. Point-to-point difference (Δ) measurements are made using two cursors.

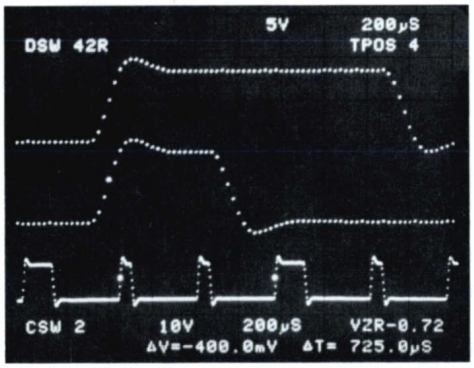
Master Menu



The master menu offers a convenient way to enable special functions such as the Store and Recall of front panel settings and also allows you to branch-out to other menus.

NEW

Measurement Flexibility

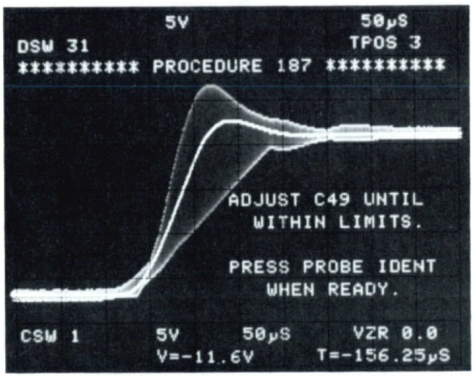


View and compare two different portions of the same waveform or of two different waveforms. All of these waveforms have been repositioned and vertically compressed. The two upper waveforms, two pulses from a single pulse train, are magnified portions of the lowest waveforms. The time (ΔT) between the two cursors indicates the time between the leading edges of two pulses in the pulse train.

Hands Off Operation With Probe Identify Feature

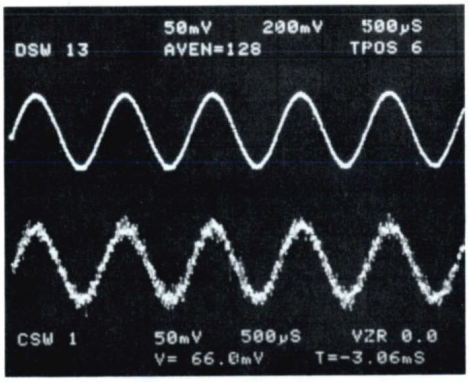
Recommended for use in interactive, computer-coordinated tasks, the Tektronix P6053B Probe allows computer routines to be sequentially activated at the 7D20's probe tip. This probe's "Identify" button signals the GPIB Interface via an input channel coded request. This capability allows the operator to work at a short distance from the 7D20 without the need to touch front panel controls. Two such probes may be used, one for each vertical channel.

Automated Testing



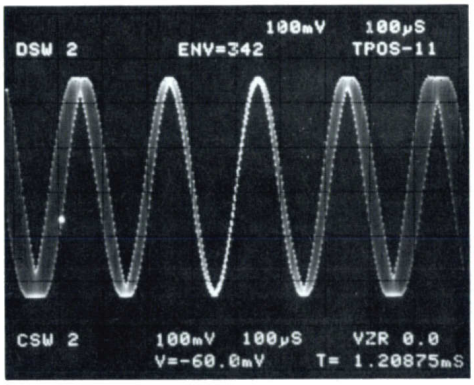
For interactive test procedures, text messages, waveforms, and front panel set-ups may be transmitted and received from the 7D20 to a controller or computer. The procedure in this display informs the operator of the next task. Upper and lower tolerance limits are displayed as a single envelope. This envelope was initially constructed using the 7D20's envelope feature while a test signal was varied to its allowable limits. The waveform was then transferred and saved by the controller to serve as the test reference or overlay.

Signal Averaging



Averaging reduces uncorrelated noise to improve measurement accuracy and display quality. Continuous and self-terminating averaging are provided. The self-terminating averaging processes a fixed number (N) of waveforms and then holds the result in memory. The N value is selectable from 8 to 256 in powers of 2. The top waveform in this display is the result of averaging the bottom waveform 128 times.

Enveloping



Enveloping reveals subtle variations in signals by recording maximum and minimum values of recurring sweeps while vectors "paint" in the envelope. The effects of frequency shift are dramatically displayed.

CHARACTERISTICS

VERTICAL SYSTEM

Input — Two channels, simultaneous sampling, BNC connectors.

Acquire Modes — CH 1, CH 2, Add, Both (dual channel).

Sensitivity — 5 mV to 5 V/div; 1-2-5 sequence.

Bandwidth — 70 MHz maximum. (Ac Coupled Low Frequency Response: 10 Hz or less.)

Step Response — 5 ns or less.

Input Impedance — 1 MΩ paralleled by ≈20 pF.

Maximum Input Voltage — Dc Coupled: 250 V, 1 kHz or less (dc + peak ac). Ac Coupled: 400 V, 1 kHz or less (dc + peak ac).

Signal Isolation — 100:1 dc to 20 MHz.

Vertical Resolution — 8 bits, 256 levels, 0.04 div/level.

Gain Ratio Accuracy — <2%. Maximum error throughout the V/div range with acquire gain calibrated at 10 mV/div. Measurement valid with Cursors or GPIB.

Noise — Mean value of 50 measurements taken at 0.02 div increments.

Volts/Div	Full Scale/RMS Noise	Percent of Full Scale
5 mV	52 dB	0.25
10 mV to 5 V	55 dB	0.18

NOTE: Full scale = 10.24 divisions.

Phase Match X-Y — <2° from dc to 10 MHz.

HORIZONTAL SYSTEM

Time Division Range — External Clock, 20 s/div to 50 ns/div in 1-2-5 sequence.

Digitizing Technique Versus Time/Division — Real Time (Rolling Display): External Clock, 20 s/div to 0.1 s/div. Real Time: 50 ms/div to 500 µs/div. Extended Real Time: 200 µs/div to 2 µs/div. Equivalent Time: 1 µs/div to 50 ns/div.

Note: Single events can be captured as fast as 2 µs/div. For 1 µs/div to 50 ns/div, repetitive events are required to build a complete waveform.

Time Measurement Accuracy — One Cursor: 0.1% of reading +0, −1 sample interval ±300 ps. Two Cursors: 0.1% of reading ±600 ps.

Horizontal Resolution

Time/Division	Points/ Waveform	Resolution Points/Division
External, 20 s to 500 µs	1024	100
200 µs to 2 µs	820*1	80*1
1 µs to 50 ns	1024	100

*1 *Waveform interpolation to 1024 points is available for transfer over the GPIB Interface.*

The 7D20T consists of the 7D20 and its own dedicated power module, for use in applications not requiring local visual display of acquired signals.

PROGRAMMABLE DIGITIZER

Trigger Position
Pretrigger: 0 to 10 div in 1 div increments. Posttrigger (delay): 0 to 1500 div in 1 div increments (disabled during Roll with Envelope or Average).

	Frequency Range*1	Sensitivity	
		Internal	External
Normal (Dc Coupling)	dc to 30 MHz	0.4 div	60 mV
	30 MHz to 70 MHz	1.0 div	150 mV
P-P and Auto	30 Hz to 200 Hz	2.0 div	300 mV
	200 Hz to 30 MHz	0.6 div	90 mV
	30 MHz to 70 MHz	1.2 div	200 mV

*1 *The ac coupling low frequency limit is 30 Hz. In Time/Div settings of 1 μs to 50 ns, when using P-P or Auto, low-frequency limit is 300 Hz.*

SIGNAL PROCESSING

Cursors Readout — With one cursor (ΔOff), vertical and horizontal coordinate values are referenced to zero volts and the trigger position as zero time. With two cursors (ΔOn), vertical and horizontal coordinate values are the difference between the two cursors.

Signal Averaging
AVE N: A self-terminating, stable average processing "N" number of waveforms and then holds the result in memory. The "N" value may be selected using the SET N function (N = 8, 16, 32, 64, 128, 256).
AVE: A continuous, stable averaging process. N waveforms are averaged as in AVEN, then additional waveforms are weighted at 1/N. In Roll mode a running average (smooth) is available to provide high frequency filtering.

Enveloping
ENV N: A self-terminating recording of waveform maxima and minima. When N waveforms are processed, the result is held in memory.
ENV: A continuous (infinite) recording of waveform maxima and minima.

Waveform Modifiers
VPUP ↑ (Vertical Position Up), VPDN ↓ (Vertical Position Down): Provide vertical positioning control of any stored waveforms.
VCMP ↕ (Vertically Compress), VXPD ↕ (Vertically Expand): Provide vertical display expansion or compression. Two expansions or compressions in 1,2,5 calibrated steps, from the original V/div are available.
HMAG (Horizontal Magnify): Displays the cursor waveform horizontally magnified by a factor of 10. HMAG ALL (Horizontally Magnify All Waveforms): Displays all waveforms at 10 times horizontal magnification.
VS (Versus): Creates a Y versus X display of any two waveforms.

GPIB INTERFACE

Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
T5	Complete talker — no secondary address
L3	Complete listener — no secondary address
SR1	Complete service request
RL1	Complete remote local
DC1	Complete device clear
DT1	Complete device trigger
PP∅	No parallel poll
C∅	No controller
E2	Three state

Programmable Functions — All instrument setting and operating modes are programmable except for Variable V/Div and Horizontal Position. However, these uncalibrated controls can be overridden and forced into the "CAL" position on command from the GPIB Interface. The display of Menu and ID is selectable from the front panel only.

Format — Device dependent commands in ASCII. Waveform data points selectable as BINARY or ASCII.

Waveform Output Time — 250 ms minimum for BINARY and 2.5 s minimum for ASCII. Actual transfer times depend upon the speed of the receiving device.

INPUTS

External Trigger (Front Panel) — Maximum Input Voltage: 250 V (dc + peak ac).

Signal Input Impedance — 1 MΩ, paralleled by ≈20 pF.

Hold Next (Mainframe Rear Panel) — Initiates Hold Next condition; connected to Single Sweep Reset connector.

OUTPUTS

Hold Next Ready — High level indicates unit is in Hold Next condition; output level remains low when unit is not in Hold Next condition; connected to Single Sweep Ready connector.

+Gate Out — Provides high level output signal for duration of waveform/character readout.

PLUG-IN COMPATIBILITY

The 7D20 is compatible with all 7000 Series mainframes with the exception of the 7104 mainframe. Use with the 7104 will void the 7104 warranty.

PHYSICAL CHARACTERISTICS

	7D20		7D20T	
Dimensions	**mm**	**in**	**mm**	**in**
Width	206	8.1	216	8.5
Height	127	5.0	183	7.2
Depth	371	14.6	566	22.3
Weight	**kg**	**lb**	**kg**	**lb**
Net	3.6	8.1	10.4	23.0
Shipping	8.0	17.8	12.0	26.6

Included Accessory — Instruction manual.

ORDERING INFORMATION

7D20 Programmable Digitizer (plug-in). **$7,750**
7D20T Programmable Digitizer.*1
7D20T Option 01 Power Module converts existing 7D20 to 7D20T.*1

*1 Price available upon request.

RECOMMENDED PROBE (7D20 and 7D20T)

P6053B Identify Probe — For remote service request via probes "Identify" button. 10X attenuation; 200 MHz bandwidth; scale factor coding; 6 ft.
Order 010-6053-13 ..... **$165**

RECOMMENDED MAINFRAME FOR 7D20

R7603 Option 20 — The R7603 mainframe provides a 6-inch diagonal CRT display and three-wide plug-in compartment in a 5.25 inch high rackmount configuration. Option 20 permits rear panel access to the 7D20's GPIB Interface. See page 250 for further information.
Order R7603 Option 20 Mainframe **$3,535**

Utility Software **$150**
Refer to page 330 for description and Ordering Information.

OPTIONAL ACCESSORY (R7603)

A field installable kit adds Option 20 to the standard R7603. Intended for use with a previously purchased R7603, this kit provides parts to connect the 7D20's GPIB Interface to the R7603 mainframe.
Order 040-1093-00 ..... **$375**

INTERNATIONAL POWER CORDS AND PLUG OPTIONS (7D20T)

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

RACKMOUNTING 7D20T

Rackmounting kits are available for rackmounting the 7D20T with various other half rackwidth products from Tektronix. Please call your local Tektronix Sales Office for descriptions, part numbers, and prices.

GPIB IEEE-488

7854

The 7854 is designed to support other products which comply with IEEE Standard 488-1978.

Waveform Parameters at the Touch of a Key

Dc to 400 MHz Bandwidth at 10 mV/div

Calibrated Sweep Rates to 500 ps/div

Stores Repetitive Waveforms up to 400 MHz (Up to 14 GHz with Sampling Plug-Ins)

Single Shot Events and Pretrigger Up to 50 μs/div (with 7B87 Time Base)

Signal Averaging

Resolution Up to 0.01 Div on Stored Data (10 Bits)

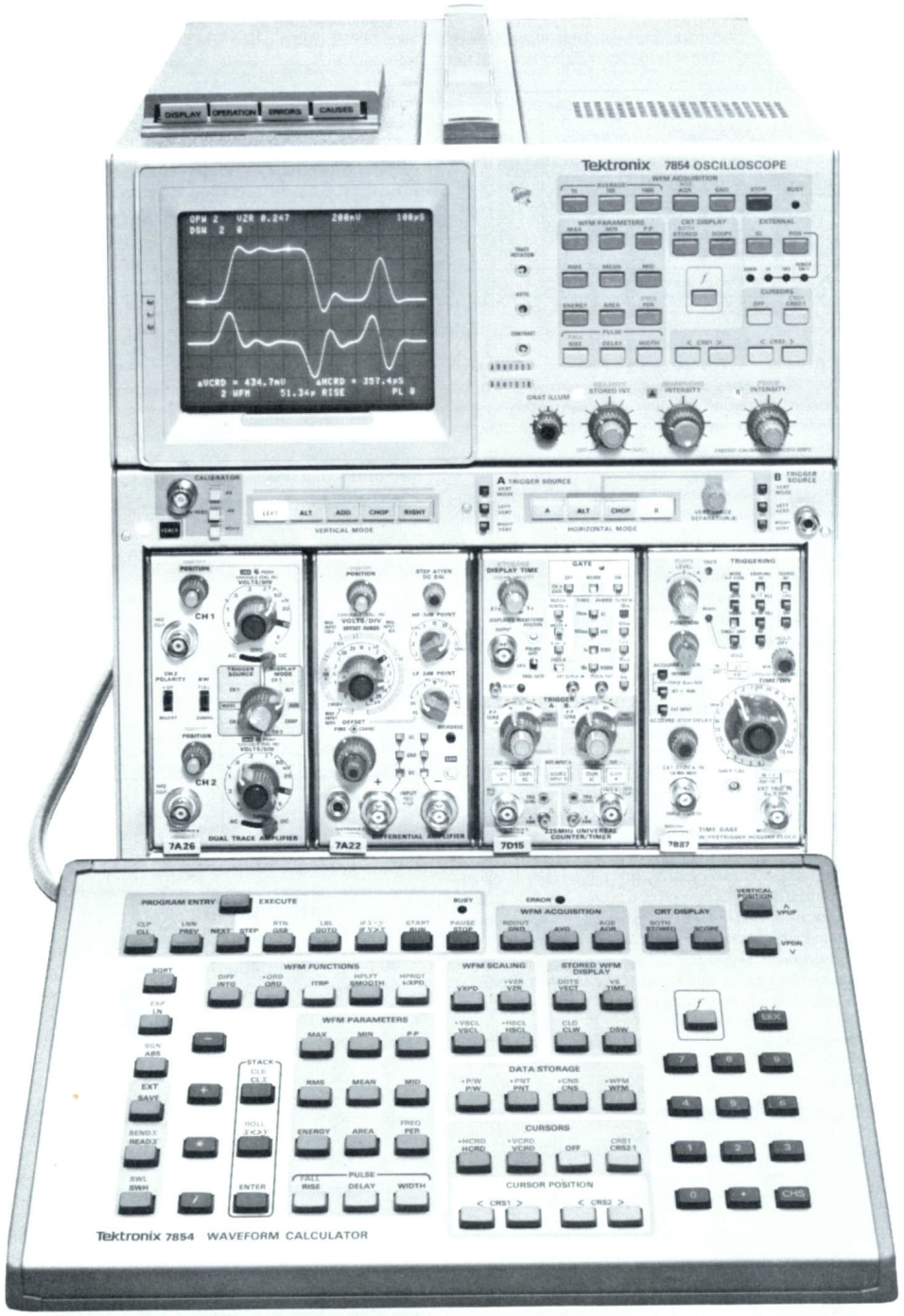
Choose 128, 256, 512, 1024 Points/Waveform

Keystroke Programming (Up to 2000 Keystrokes with Option 2D)

GPIB Interface (Standard)

APPLICATIONS

* **Power Supply Testing**
* **Fiber Optics**



The 7854 Waveform Processing Oscilloscope represents a unique approach to today's test and measurement problems. It combines the features of a high performance real time oscilloscope with digital storage and waveform processing. When integrated with any of a wide variety of 7000 Series plug-ins, it becomes a very powerful measurement system. The 7854 offers programmable measurement routines, GPIB interface for mass data and program storage plus simultaneous display of real time and stored waveforms. The 7854's on-board memory can store up to 40 waveforms and 2000 keystrokes with Option 2D.

Mainframe and calculator keyboard functions provide cursor control and waveform parameter information at the touch of a button, e.g., maximum, minimum, peak-to-peak, rise. Additional features on the calculator keyboard enable arithmetic manipulation of waveforms such as differential, integral, log, and absolute value.

Signal averaging can recover signals buried in random noise and improve measurement accuracy. One or two cursors are selectable for voltage and time measurements. One cursor provides voltage measurements referenced to ground and time measurements referenced to time zero. Two cursors enable Δtime and Δvoltage measurements. Cursors may also be used to bracket an area of interest for measurement consideration.

For single-shot applications, the 7B87 Time Base plug-in allows storage of events that occur prior to a trigger (pretriggering). The amount of pretrigger data may be varied continuously from 0.2 divisions of pretrigger to 9.9 divisions.

The 7854's keystroke programming (simply storing a series of keystrokes to be executed) assures repeatable measurement results and lowers the skill level needed to operate the system. Measurement loops can be written to save time, log results and make pass/fail decisions. Full subroutine and conditional branching capabilities are provided.

CHARACTERISTICS

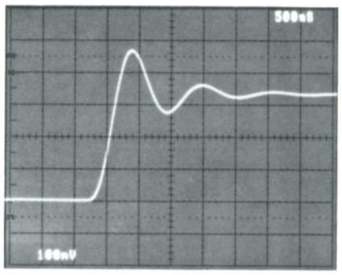
VERTICAL REAL TIME SYSTEM

Input — Two plug-in compartments; compatible with 7000 Series plug-ins.

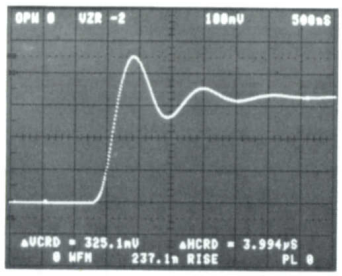
Modes of Operation — Left, Alt, Add, Chop, Right.
Mainframe Bandwidth — 400 MHz with 7A29 or 7A19 Amplifier plug-in.
Mainframe Step Response — 0.9 ns or less with 7A29 or 7A19 Amplifier plug-in.
Chopped Mode — Chop rate is ≈1 MHz.
Delay Line — Permits viewing leading edge of displayed waveform (7B50 Series time bases not recommended for 7854 except 7B50A).
Trace Separation Range — In dual-sweep modes, B trace can be positioned 4 div above or below the A trace.

CRT AND DISPLAY FEATURES

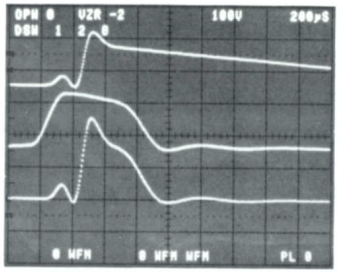
CRT Display Modes
Scope (Conventional display.)
Stored (Digital data display.)
Both (Stored display plus real time waveforms.)
Program Entry (User program text display.)



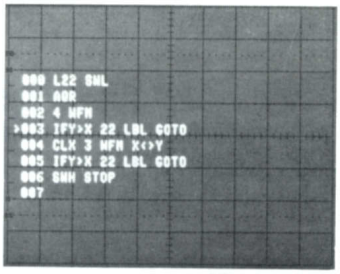
Conventional Scope: In the SCOPE mode, the 7854 provides a complete plug-in scope giving standard displays like other Tektronix high performance scopes.



Storage Scope: Risetime is calculated by pushing a single key. Time and voltage differences between cursors are shown on the line above risetime.



Multiple Storage and Calculation: Volts, current, and power are all shown on the display. Power is a simple two or three keystroke calculation.



Waveform Processing: Keystroke Programming enables the user to design measurement routines tailored to individual tests or experiments.

HORIZONTAL REAL TIME SYSTEM

Input — Two plug-in compartments; compatible with 7000 Series plug-ins. 7000 Series vertical amplifiers and specialized plug-ins may also be used.*1

Modes of Operation — A, Alt, Chop, B.

Fastest Calibrated Sweep Rate — 0.5 ns/div.

Chopped Mode — Rep rate is ≈200 kHz.

X-Y Mode — Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction, (dc to 1 MHz with phase correction, B horizontal only, Option 02).

*1 *See plug-in compatibility for exceptions for digital storage.*

PROGRAM STORAGE

Keystroke programming allows the mainframe to remember a sequence of keystrokes (with remote waveform calculator or GPIB*1).

Editing — Line by line editing capability.

*1 *Mainframe vertical and horizontal modes and all other keys except edit commands are programmable.*

DIGITAL STORAGE

Equivalent Time Bandwidth — 400 MHz. See 7000 Series system bandwidth specifications.

Accuracy — Refer to plug-in specifications.

Acquisition Channels — One or two simultaneous channels (Plug-in Chop mode not valid).

Acquisition Window — ±5 div from center screen both vertical and horizontal.

Resolution

Vertical: 0.01 div.

Horizontal: Selectable points/waveform on remote keyboard.

Horizontal Resolution (divs)	Points/Waveform
0.01	1024
0.02	512
0.04	256
0.08	128

PLUG-IN COMPATIBILITY

All 7000 Series plug-ins are compatible in the standard oscilloscope display mode. The 7L5 and 7L18 Spectrum Analyzers require factory modification for optimum use with digital storage operation. The 7D01, 7D02 and 7T11 are not compatible in Stored mode.

The 7B87 provides pretrigger for the 7854. Pretrigger allows you to view what has occurred before the trigger event in single shot applications. The amount of pretrigger time is determined by the Acquire-Stop delay time setting. The total amount of pretrigger is 0.2 to 9.9 times the time/div setting.

Single Shot Performance — Using 7B87 with 7854 Internal clock.

Ext Clock — 2 μs/point maximum.

Fastest Sweep (Time/Div)	Points/Waveform
50 μs	128
100 μs	256
200 μs	512
500 μs	1024

OUTPUTS/INPUTS

+Sawtooth — Positive-going with baseline at 0 V ±1 V into 1 MΩ. Voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is ≈950 Ω.

+Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Output R is ≈950 Ω. Source is selectable from A gate, B gate, or Delayed gate.

Vertical Signal Out — Selected by A Trigger Source switch. Output voltage is 0.5 V/div into 1 MΩ, 25 mV/div into 50 Ω. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in.

Remote Single Sweep Reset — Rear panel BNC, ground closure activated.

MEMORY FORMAT

	STANDARD				OPTION 2D			
Points Per Waveform*1	128	256	512	1024	128	256	512	1024
Maximum No of Waveforms	16	8	4	2	40	20	10	5
Maximum No of Constant Registers	50				100			
Maximum No of Prog Commands plus lines	920				2000			

*1 *Unless otherwise selected, default value is 512 at power-up.*

TTL Output — Rear panel BNC, TTL output under remote keyboard control (SWH and SWL).

External Z-Axis Input — 2 V p-p for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

Camera Power Output — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

Memory Back-Up Power Input — 6.0 V to 6.5 V at 0.7 amp to preserve stored data if mainframe's power is interrupted.

GPIB INTERFACE

Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
T5	Talker function
L3	Listener function
SR1	Complete service request capability
RL1	Complete remote/local capability
DC1	Complete device clear capability
DT1	Complete device trigger capability

I/O Records — Waveforms constants, program text, and display text.

End of Message Terminator (Selectable in Talk/Listen Mode for EOI or LF/EOI). — Compatible with Tektronix and other popular controllers.

Device Address — Selectable via rear panel switch.

Remote Operation — All keystroke functions and vertical and horizontal modes can be remotely operated via the GPIB.

CALIBRATOR

Voltage Output — Squarewave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; rep rate is 1 kHz within 0.25%.

Current Output — 40 mA available through Calibrator output with optional BNC to current loop adaptor.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V to 132 V. 180 V to 250 V.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 230 W.

PHYSICAL CHARACTERISTICS

Dimensions, Mainframe	mm	in
Width	305	12.0
Height	348	13.7
Depth	627	24.7
Waveform Calculator	**mm**	**in**
Width	277	10.9
Height	69	2.7
Depth	165	6.5
Cord Length (within 76 mm)	1420	56.0
Weights	**kg**	**lb**
Net	20.4	45.0
Shipping	28.2	62.0

INCLUDED ACCESSORIES

Power cord (161-0066-00); BNC-to-BNC cable (012-0208-00); instruction manual.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

7854 Oscilloscope (Including Waveform Calculator) **$14,230**

Option 02 — X-Y Phase Correction ..... **+$250**

Option 03 — EMC Modification ..... **+$300**

Option 2D — 4 k Expanded Memory ..... **+$250**

Field Option 2D Kit — Order 040-0941-00 ..... **$300**

Option 78 — BE (P11) Phosphor ..... **+$100**

INTERNATIONAL POWER CORDS & PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A,50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

7B87 Time Base required only for pretrigger and single shot digitizing **$1,670**

SYSTEMS

The 7854 is also available as a WP1310 Signal Processing System. This system is a synergistic combination of the Tektronix 7854 Oscilloscope and 4052A Graphic Computer. Together, these two instruments automate the entire waveform test and measurement process, from acquisition and calculation to storage and display formatting.

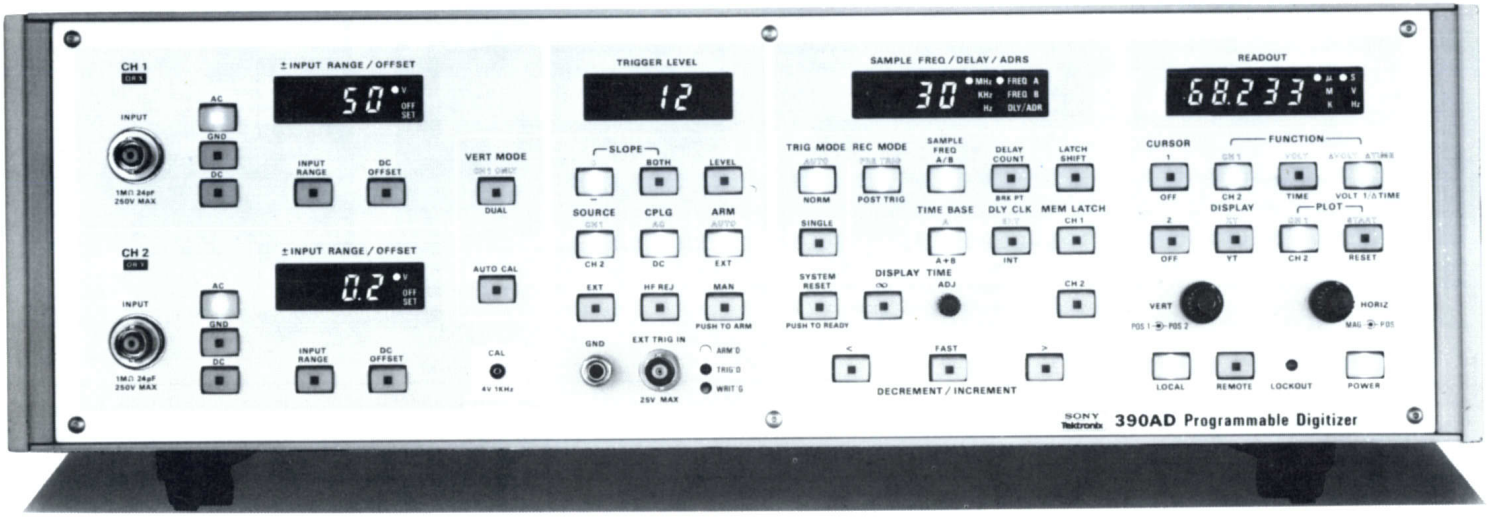
7854 Based Waveform Processing Workshop

The two-day course consists of interactive lectures and labs, covering all 94 commands and operators which are available both locally and over the GPIB Interface.

With the purchase of each Tektronix 7854 Oscilloscope, the customer is entitled to one tuition-free attendance at a regularly scheduled workshop.

Tektronix also offers service training classes on the 7854 Waveform Processing Oscilloscope.

For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Customer Training Workshop Schedule or the Tektronix Service Training Catalog on the return card in the center of this catalog.



GPIB IEEE-488

390AD

The 390AD complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

True Dual Channel 30 MHz Sampling Rate (60 MHz in Single Channel Mode)

10-Bit Resolution

2048 Word Memory Per Channel (4096 Single Channel Mode)

Cursor-Based Measurements

Sample-Rate Switching

Direct Plotter Output Capabilty

APPLICATIONS

- **Extracting Information from Signals Containing Components from dc to 15 MHz**
- **Ultrasonics/Stress/Strain**
- **Mechanical/Vibration**
- **Audio**
- **ATE**
- **Laser Spectroscopy**
- **Biomedical Research**
- **LIDAR**
- **Geo-Seismic**

Used for low-to-medium-speed signals, the 390AD Programmable Waveform Digitizer provides crystal-controlled, 30-MHz sampling on two channels. Or, a single channel of data may be digitized at up to 60 megasamples per second.

Features include 10 bit vertical resolution, dual-channel synchronized digitizing, pretriggering and posttriggering, sample-rate switching during acquisition, internal cursors for two-point time or voltage measurements and 2048 words of memory per channel. Excellent dynamic accuracy is achieved using a two-stage flash-conversion process.

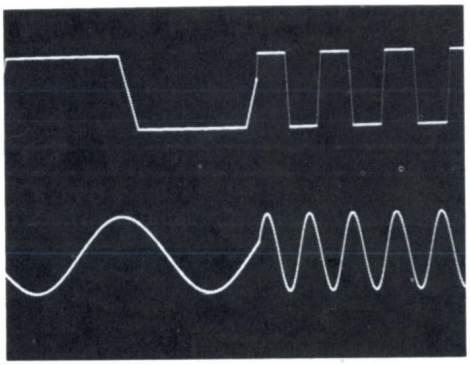


Figure 1. Photo showing sample of Rate Switching. In this example switching occurs at the 1024th sample, to extend the display window. The sample rate can be either increased or decreased at the trigger point. A minor time discontinuity may occur at the trigger point under some conditions.

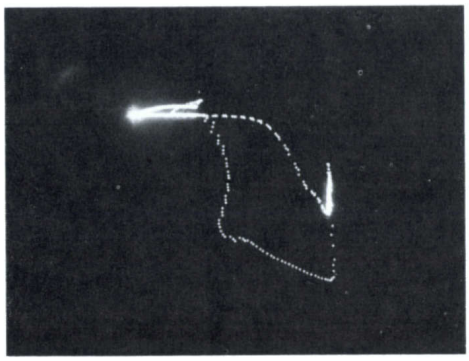


Figure 2. The 390AD display is set to X vs Y mode. Rolling channel 1 or 2 will produce a "correlation" indicative figure.

The X versus Y display mode coupled with the shift mode function provides a powerful tool for visual comparison of related phenomena.

To ensure reliable operation and high accuracy, the 390AD includes Auto Cal (self-calibration) and self-test features during operation.

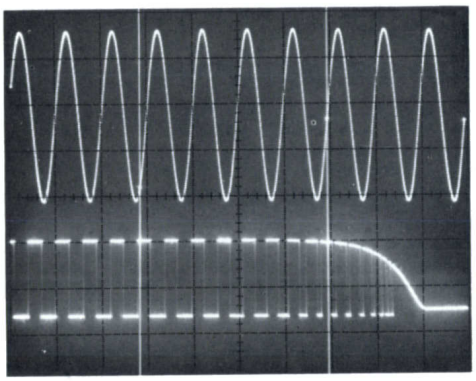


Figure 3. Two cursors may be positioned by the user or controller, at points of interest on either waveform. The voltage difference, time difference, or 1/time difference, as well as the absolute values may be directly read from the LED display, or sent to a controller. Positioning may be precisely accomplished with the aid of the "zoom" feature.

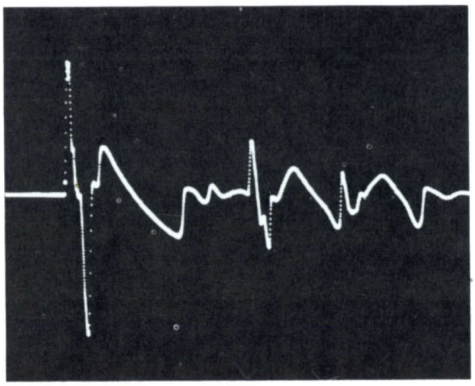


Figure 4. Complex manual setups may be avoided by recording the desired instrument settings for a particular measurement on a system peripheral device, then sending the English-like command string to the 390AD. [e.g., the above signal was digitized with a horizontal record of 4k samples as per the instructions of the 4052A Desktop Computer (Figure 5 following page)].

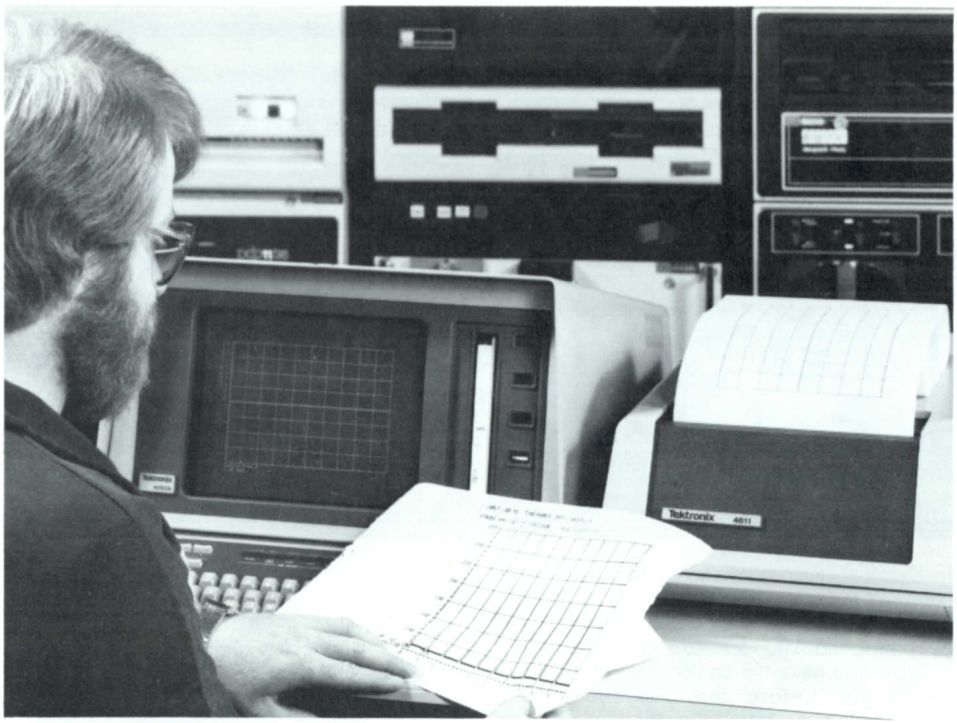


Figure 5. The 390AD can be easily integrated into wide range of GPIB systems. Shown above is 4052A Desktop computer with 4611 Hard Copy Unit.

CHARACTERISTICS

VERTICAL

Input Channels — Two, single ended.

Sensitivity — ±100 mV to ±50 V full scale (200 mV p-p to 100 V p-p) 9 steps, 1-2-5 sequence.

Input R and C — 1 MΩ ±2%; paralleled by ≈24 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac). Ac Coupled: 500 V (dc + peak ac).

Bandwidth — Dc to 15 MHz (−3 dB). Lower −3 dB point, Ac Coupled: 10 Hz.

Input Dc Offset Voltage — 0 to ±99% full scale, 1% step. Accuracy: <0.5%.

Automatic Calibration — Gain Accuracy: ±0.4%. Dc Drift Accuracy: <±0.1%.

TIME-BASE A AND B

Sample Rate — Internal: CH 1 Only: 5 Hz to 60 MHz, 23 steps, 1-2-5 sequence except 30 MHz and 60 MHz. Dual: 5 Hz to ≈30 MHz, 22 steps. External: Dc to 60 MHz.

Clock — 60 MHz ±10 ppm, crystal-controlled.

TRIGGERING

Sources — Internal CH 1 and CH 2 or external.

Coupling — Ac, dc, HF Rej.

Slope — Positive, negative, both.

Level Range — Internal: 0 to ±99% full scale, 1% step. External: ±4.95 V, 0.05 V step.

Trigger Sensitivity

Coupling	Trigger Frequency Range	Minimum Signal Required	
		Internal	External
Ac	25 Hz to 15 MHz	30 LSB	300 mV p-p
HF Rej	25 Hz to 50 kHz	30 LSB	300 mV p-p
Dc	Dc to 15 MHz	30 LSB	300 mV p-p

Arming — Auto, Manual, External.

DIGITIZING

Vertical Resolution — 10 bits (1/1024).

Sample Rates — Dual Channel Mode: 30 MHz. CH 1 Only Mode: 60 MHz.

Aperture Jitter (Including Internal Clock) — 150 ps, nominal.

Dynamic Accuracy*1

Signal Frequency	Effective Bits
≤1 MHz	≥8.75
≤10 MHz	≥8.25
≤14 MHz	≥7.75

**1 Sampling frequency at 30 MHz. For further information refer to HANDSHAKE Vol 5 No 1, 33-A-4463.*

Record Length — Dual Channel Mode: 2048 words/channel. CH 1 Only Mode: 4096 words.

Modes — Auto, Norm, Single.

Pretrigger Range — CH 1 Only Mode: 0 to 4092. Dual Channel Mode: 0 to 2046.

Posttrigger Range

Time Base	Vertical Mode	Range
A	Dual	0 to 9998
	CH 1 only	0 to 9998
A+B	Dual	0 to 2046
	CH 1 only	0 to 4092

A Time Base — Recording is taken at one rate (sample frequency A) continuously.

A+B Time Base — Pretrigger Mode: Sample frequency A is switched to B at trigger. Recording stops at delayed trigger. The transition point (switch point) is well defined. Posttrigger: Sample frequency A is switched to B at delayed trig and recording stops after total of 2048 (or 4096) samples.

Stored digital data are addressable by key entry while monitoring cursors on the waveform.

Readout Display — 5 digit LED (Reads voltage difference on the same waveform or between CH 1 and CH 2, absolute voltage, time interval, and 1/T.

OUTPUTS

CRT Display — X: 1 V p-p Ramp (changeable to 5 V p-p by internal strap). 8 ms: Dual. 16 ms: CH 1 only. Mag gain X1 to X10 variable. Y: 1 V p-p (changeable to 5 V p-p by internal strap). Z: 0 to 1 V (changeable to 0 to 5 V by internal strap), selectable polarity. X-Y Plot: Output Voltage is 0 to 5 V. Plot Speed is 20, 50, 100 ms/word: Auto Slow, or Auto Fast modes. (Modes are selected by internal strap.)

Voltage Calibrator — Rectangular 1 kHz (±10^{-5}), 4 V (±1%).

Rear Panel Connectors — CRT-X, CRT-Y, CRT-Z, INT CLK-OUT, EXT CLK-IN, EXT ARM-IN, EXT DLY CLK-IN, PLOT-X, PLOT-Y, PLOT-PEN, WRITE END, GPIB.

GPIB INTERFACE

Standard — Conforms to IEEE Standard 488-1978.
Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
T6	Basic talker
L4	Basic listener
SR1	Complete service request capability
RL1	Complete remote/local capability
PP0	No parallel poll
DC1	Complete device clear capability
C0	No controller function
DT1	Complete device trigger capability

Interface Control Message — GTL, LLO, SDC-DCL, GET, SPE-SPD, IFC.

Programmable Functions — All instrument setting and operating modes are programmable, except power switch, vertical/horizontal position, horizontal mag, and external clock switch.

Format — Commands in ASCII, Waveform data in 2 byte/point high byte first.

ENVIRONMENTAL CHARACTERISTICS

Temperature Range — Operating: 0°C to +40°C. Nonoperating: −25°C to +70°C.

Altitude — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

Line Voltage Range — 90 V ac to 132 V ac (115 V); 180 V to 250 V ac (230 V).

Line Frequency — 48 Hz to 440 Hz.

Power Consumption — 240 W.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	446	17.6
Height	152	6.0
Depth	540	21.3
Weights	**kg**	**lb**
Net (without accessories)	15.5	34.0

INCLUDED ACCESSORIES

Power cord (161-0066-00); GPIB cable (012-0630-03); two 4 A fast-blow fuses (159-0017-00); 390AD Programming Aid (070-4467-00); instruction manual.

ORDERING INFORMATION

390AD Programmable Digitizer **$14,530**
Option 10 — Rackmount 390AD ..... **+$250**
Utility Software **$150**
Refer to page 330 for description and Ordering Information.

INTERNATIONAL POWER CORD AND PLUG OPTIONS

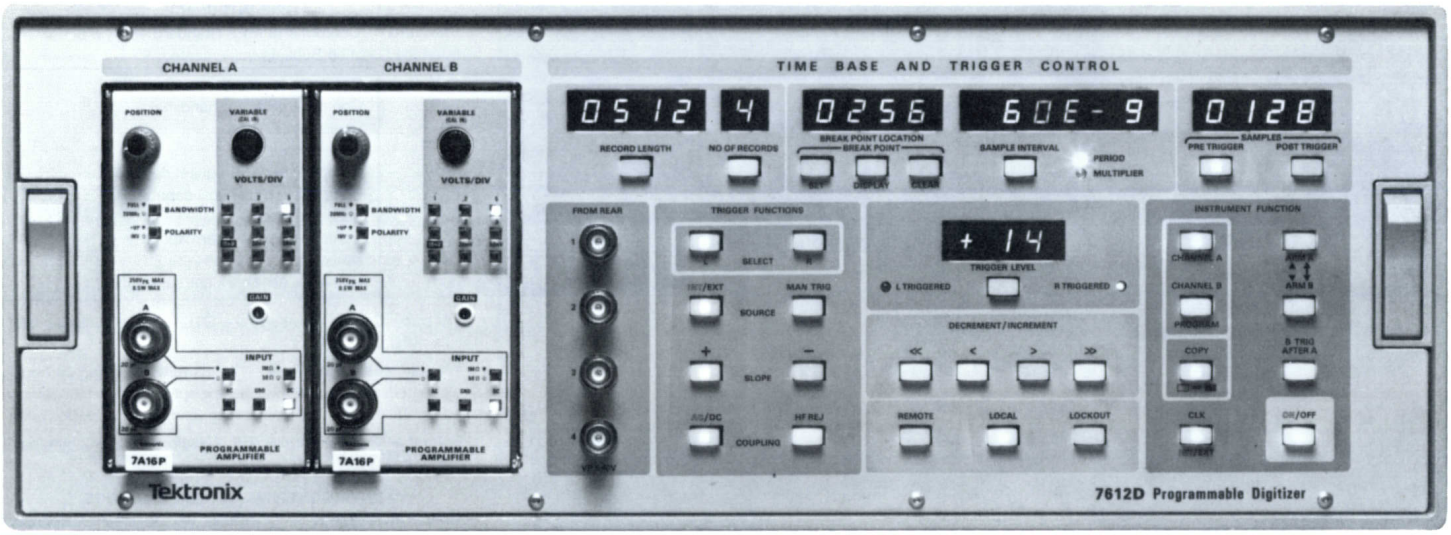
Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

OPTIONAL ACCESSORY

390AD Service Manual.

The 620 monitor is recommended for use with the 390AD. See Alphanumeric Index.

The SONY®/TEKTRONIX® 390AD is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 390AD is available from Tektronix, Inc., its marketing subsidiaries and distributors.



GPIB IEEE-488

7612D

The 7612D complies with IEEE Standard 488-1975, and with Tektronix *Standard Codes and Formats*.

200 MHz Maximum Sampling Rate

Two Channels, Two Time Bases

8 Bit Resolution

2048 Words of Memory per Channel

5 ns to 1 s Selectable Sampling Intervals with Interval Switching Allowed During Waveform Acquisition

Pretrigger and Posttrigger Operation

Fully Programmable Over GPIB for System Oriented Operation

APPLICATIONS

- **Automated Testing**
- **EMP**
- **Nondestructive Testing**

The 7612D Programmable Digitizer is a dual-channel, dual time base waveform digitizer for use under computer control. It has a maximum sampling rate of 200 MHz. Each channel has its own analog-to-digital converter, a new type designed by Tektronix for accurate, high-speed waveform digitizing. Each channel also has its own time base operating from a single 200 MHz crystal-controlled clock. The result...two fully independent channels capable of capturing one waveform each, simultaneously, with the same or different vertical sensitivities and time-base settings.

And there's still more flexibility available. The number of samples per waveform (record length) can be selected, from 256 to 2048. The sample rate can be changed during waveform digitizing, for example, using dense sampling on fast transitions and switching to sparser sampling for slow decays. Also, each channel's local memory can be partitioned into one to eight equal-length records. You have the choice, too, of looking at waveforms before the triggering event (pretrigger), immediately after the trigger, or delayed from the trigger (posttrigger). Or you can choose to operate the channels dependently by triggering one after the other.

All 7612D functions can be selected manually or operated under program control over the GPIB. Add two 7A16P Programmable Amplifier plug-ins, one for each channel, and you have program control over every waveform acquisition function.

Extracting information from medium-speed signals is a typical application of 7612D systems.

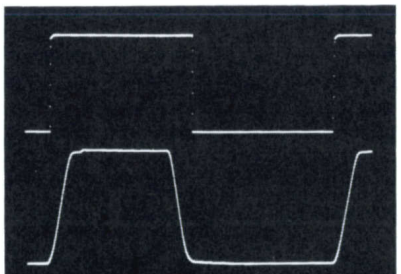


Figure 1. The complete period of a signal (top trace) is recorded at 200 ns; by changing the sample rate to 10 ns during risetimes and falltimes and 800 ns during the plateau (bottom trace), you can measure risetime, falltime, pulse width and interval accurately on a single-shot signal.

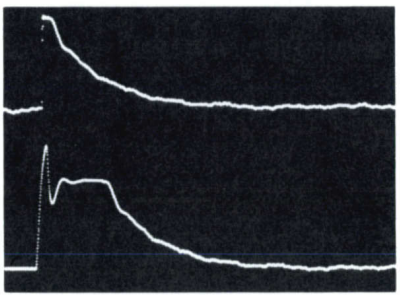


Figure 2. A decaying signal recorded at a 10 μs sampling rate (top trace); the same signal can be recorded at a 100 ns sampling rate during the initial portion and switched back to a 10 μs sampling rate (bottom trace), to capture all information on a single-shot signal.

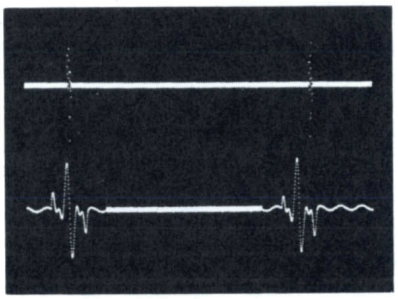


Figure 3. A signal with two echoes recorded at a uniform sampling rate (top trace), the same signal recorded at an increased sampling rate during each echo (bottom trace), to capture each echo with increased resolution.

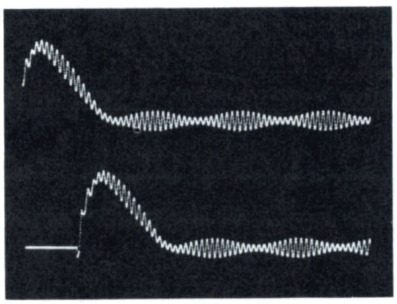


Figure 4. A transient response of a system at power-up recorded with no pretrigger (top trace); by using the pretrigger the complete response can be digitized (bottom trace).

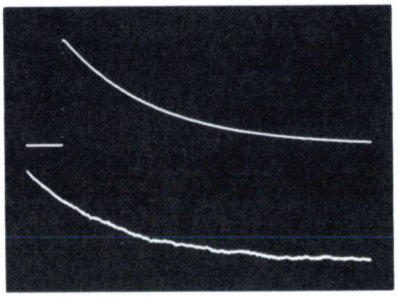
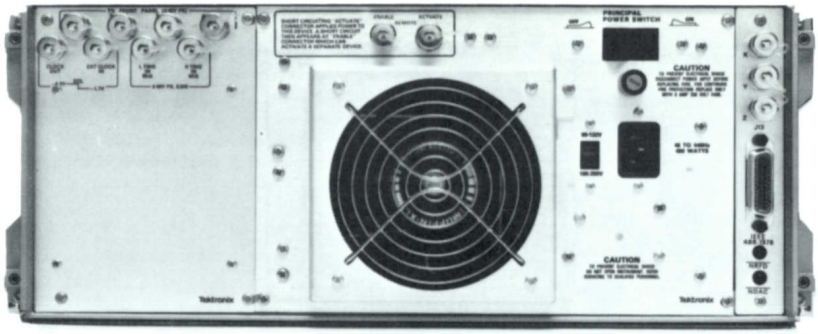


Figure 5. The initial portion of an exponential decay is recorded on Channel A (top trace); Channel B, set at a higher sensitivity and triggered to record after Channel A has finished, captures the remaining pulse tail with increased vertical resolution (bottom trace).



7612D rear panel: the GPIB connector and outputs for an X-Y-Z monitor (right); clock input/output, trigger inputs, and BNC connectors to feed signals to the front panel (left): remote power ON/OFF is also provided through the two central BNC connectors.

CHARACTERISTICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments compatible with all 7000 Series amplifier plug-ins. Fully programmable when 7A16P plug-ins are used.
Bandwidth — 80 MHz with 7A16P plug-in.
Modes of Operation — Left channel with Time Base A and right channel with Time Base B.

TIME BASES A AND B

Type — Two built-in digital time bases with a common crystal-controlled clock.
Clock — Internal: 200 MHz ±0.0035%. Stability: Within 10 ppm/year. External: From signal source ≤200 MHz.
Sample Interval — With Internal Clock: Selectable from 5 ns to 1 s in a 1, 2, 3...9 sequence (excluding 6, 7, 8 and 9 ns). With External Clock: Selectable from 1 to 200 x 10^6 times the external clock period in a 1, 2, 4, 6...20 sequence.
Interval Switching — Sample interval can be changed up to 13 times/waveform record with preservation of time relationships.
Time Measurement Accuracy — 0.0035% (stability 10 ppm/year).
Modes of Operation — Time Base A with left channel and Time Base B with right channel. Independent or B triggerable after A completes its acquisition.

TRIGGERING A AND B

Source — Left or right plug-in, external, manual by push button.
Mode — Single sweep.
Coupling — Ac, dc, ac HF Rej, dc HF Rej.
Slope — Positive or negative.
Level Range — Internal: At least ±128 LSB in 256 steps. External: At least ±1.28 V in 256 steps.
Trigger Jitter (Internal) — 0.1 ns or less, dc to 100 MHz.
Triggering Error — ±1 sample ambiguity in recognizing the trigger, 1 sample maximum recognition error between channels (using same trigger channel for both time bases).
Trigger Sensitivity

Coupling	Triggering Frequency Range	Min Signal Required	
		Internal	External
Ac	40 Hz to 50 MHz	20 LSB	100 mV
	50 MHz to 100 MHz	44 LSB	100 mV
Ac HF Rej	40 Hz to 50 kHz	20 LSB	100 mV
Dc	dc to 50 MHz	20 LSB	100 mV
	50 MHz to 100 MHz	44 LSB	100 mV
Dc HF Rej	dc to 50 kHz	20 LSB	100 mV

ARMING A AND B

Push button or computer control.

DIGITIZING AND STORAGE

Method — Continuous, sequential digitizing of the input signals with storage of samples selected by instrument settings.
Resolution — Eight bits.
Dynamic Accuracy[*1]

Signal Frequency	S/N Ratio	Effective Bits
300 kHz	42.0 dB	7.8
20 MHz	32.0 dB	6.0
80 MHz	20.0 dB	4.0

*[*1] Signal to noise ratio performance at 25° C for a half scale sinewave input signal (an ideal eight bit digitizer would give a S/N ratio of 43.8 dB). For further information refer to HANDSHAKE VOL 5 NO 1, 33-A-4463.*

Internal Memory — Type: ECL. Size: 2048 8-bit/channel, total of 4096 8-bit words.
Record Length, A or B — 256, 512, 1024, or 2048 samples. Number of Stored Records: Up to eight 256-word, four 512-word, two 1024-word, or one 2048-word records/channel (each requires a trigger). Trigger is automatically rearmed after each record acquisition.
Pretrigger Delay Range — Selectable in multiples of eight samples. Without Sample Interval Switching: From 0 up to 16 samples less than the record length. With Sample Interval Switching: From 0 up to 16 samples less than the position of the first sample interval change.
Posttrigger Delay Range — Selectable in multiples of eight samples from eight to the record length (requires selection of only one record).

OUTPUTS/INPUTS

X, Y, Z Analog Output — Provides for analog display of data in memory. X and Y level is 1 V p-p into 100 kΩ or greater; adjustable from 0.75 V to 1.3 V. Z level is 0 to 1 V (full white) into 100 kΩ or greater.
Clock Out — Provides internal clock signal at ECL level.
External Clock In — ECL levels. ≤1 ns risetime and falltime. 2.5 ns minimum pulse width and ≤200 MHz.
L and R Trig In — Provide external trigger input to the left and right trigger channels (50 Ω terminated).
1, 2, 3, 4 — Four feed-through connections to the front panel.
Digital Interface — Conforms to IEEE Standard 488-1975.

GPIB INTERFACE

Standard — Conforms to IEEE Standard 488-1975.
Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
TE6	Extended talker function
LE4	Extended listener function
SR1	Complete service request capability
RL1	Complete remote/local function
PP0	No parallel poll
DC1	Complete device clear capability
C0	No controller function
DT0	No device trigger

Response to Interface Control Messages — The 7612D responds to the following interface control messages:

GTL	Go to local
LLO	Local lockout
SDC-DCL	Selected device clear and device clear
SPE-SPD	Serial poll enable and disable
IFC	Interface clear

GPIB Addresses — Mainframe and programmable plug-ins share a common primary address and are differentiated through the use of secondary addresses.
Programmable Functions — All instrument settings and operating modes are programmable.
Format — Commands in ASCII, waveform data in binary (range 0 to 377_8).
Transfer Rate — 710 kbytes/s maximum.
Waveform Transfer Time — To an Infinitely Fast Controller: 8.35 ms for one 2048 points record. Actual transfer time depends on controller and software speed.

ENVIRONMENTAL

Temperature Range — Operating: 0°C to +40°C. Nonoperating: −62°C to +85°C.
Altitude — Operating: −76 m to +4600 m (−250 ft to +15,000 ft). Nonoperating: −76 m to +15 000 m (−250 ft to +50,000 ft).

POWER REQUIREMENTS

Line Voltage Range — 90 V to 132 V ac, 180 V to 250 V ac.
Line Frequency — 48 Hz to 440 Hz.
Power Consumption (Including Plug-ins) — Maximum 400 W, 5 A at 115 V 60 Hz.
Remote Control — Power On/Off capability is provided.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	178	7.0
Depth	703	27.7
Weights	**kg**	**lb**
Net	25.0	55.0

INCLUDED ACCESSORIES

GPIB cable (012-0630-03); set of rack slides (351-0375-01); power cord (161-0066-00); instruction manual.

7A16P

Fully Programmable Plug-In for 7912AD or 7612D Digitizers Only

10 mV/div to 5 V/div Calibrated Deflection Factors

200 MHz Bandwidth (7900 Family)

50 Ω or 1 MΩ Input Selectable

The 7A16P is designed for use in Tektronix 7000 Series programmable digitizers. All of the normal operational features of a high-quality, wide-band 7000 Series plug-in amplifier are provided in the 7A16P. These are available at the front panel for manual selection, or they can be set under program control via a programmable mainframe and the GPIB. Whether operated manually or under program control, the front-panel push buttons light to indicate plug-in status. Plug-in status can also be read over the GPIB by an external controller for input to instrument setup and control routines.

Two switch selected input connectors are also provided for selecting input signal source.

CHARACTERISTICS

Bandwidth — Plug-in Only: 225 MHz. With the 7912AD: 200 MHz. Bandwidth may be limited to 20 MHz ±3 MHz by bandwidth limit switch.
Ac Coupled Lower Bandwidth — 10 Hz or less.
Step Response — 50 Ω input plug-in only, 1.8 ns risetime.
Deflection Factor — 10 mV/div to 5 V/div, 9 steps in a 1-2-5 sequence. Accuracy is ±2% of indicated deflection factor with Gain adjusted at 10 mV/div. Uncalibrated Variable is continuous between steps and extends selected deflection factor to at least 2.5 times the calibrated value.
Input R and C — Selectable: 1 MΩ within 2% and paralleled by ≈20 pF or 50 Ω ±1 Ω with vswr ≤1.5:1 at 200 MHz or less.
Inputs — Selectable A or B signal input connectors.
Maximum Input Voltage — 1 MΩ, Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 1 MΩ, Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 50 Ω: 0.5 W maximum.
Programmable Functions — All functions except Variable, Gain, and Identify are programmable.
Included Accessory — Instruction manual.

ORDERING INFORMATION

7612D Programmable Digitizer **$27,325**
7A16P Programmable Amplifier **$2,330**

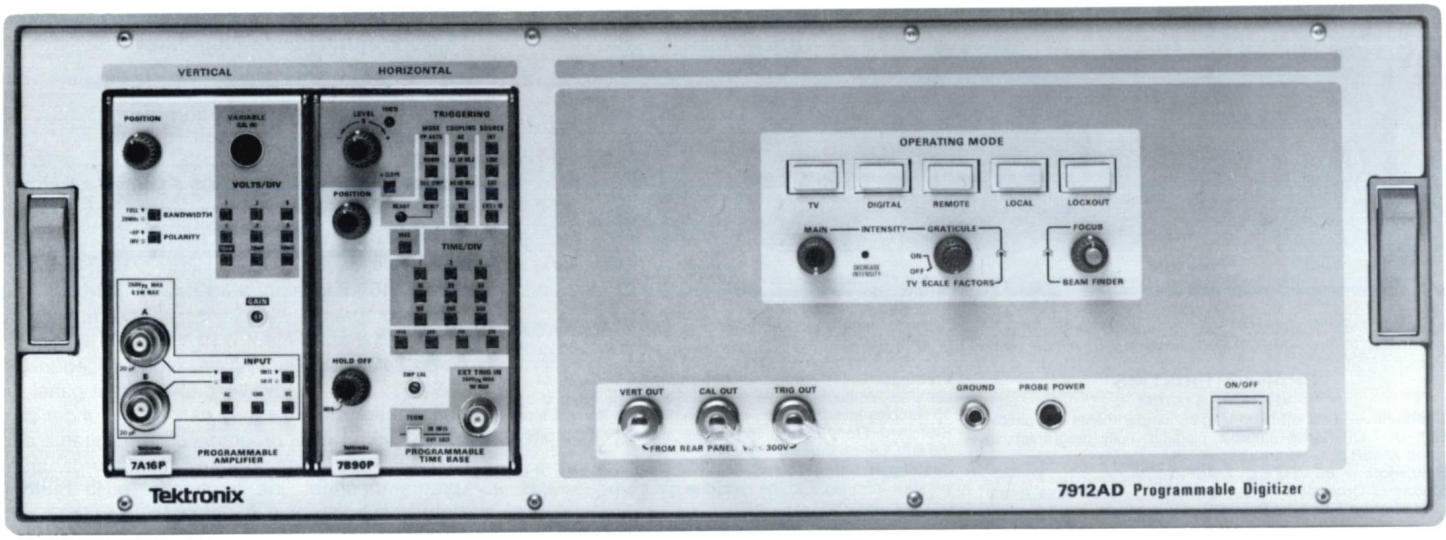
INTERNATIONAL POWER CORDS & PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

SYSTEMS

The 7612D is also available in WP3000 Series signal processing systems. These fully automatic systems are designed, assembled, tested, and documented to satisfy the demand for speed, automation, accuracy, and repeatability in characterizing devices or phenomena which give rise to waveforms in the second to submicrosecond range. For more information on these systems, contact your local Tektronix Sales Engineer.

Tektronix offers service training classes on the 7612D Programmable Waveform Digitizer. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.



7912AD shown with the 7A16P and 7B90P programmable plug-ins.

GPIB IEEE-488

7912AD

The 7912AD complies with IEEE Standard 488-1975, and with Tektronix *Standard Codes and Formats*.

Digitize and Store Single-Shot or Repetitive Signals from Millisecond to Subnanosecond Duration

500 MHz Bandwidth at 10 mV/div

500 ps/div Fastest Calibrated Sweep Rate

Waveform Digitizing to 9-Bit Vertical and 9-Bit Horizontal Resolution

Built-In Signal Averaging Capability

Fully Programmable Over GPIB For System Oriented Operation

APPLICATIONS

- **Destructive Testing**
- **Laser Research**
- **Automated Testing**

Capturing high-speed waveforms is the 7912AD's forte. Each waveform can be sampled up to 512 times within a selectable time window, ranging from ten milliseconds to five nanoseconds (50 kHz to 100 GHz equivalent sampling rate).

This performance is accomplished by a Tektronix scan converter which writes the signal onto a silicon-diode target array. In TV mode, the signal information is read from the target and converted to composite video for a bright display on a television monitor. However, in the Digital mode the waveform data is read into an internal memory. From this memory, the digitized waveform can be transferred via the GPIB to an external controller for processing.

The 7912AD Mainframe is programmable over the same GPIB. When the programable plug-ins (one 7A16P Programmable Amplifier and one 7B90P Programmable Time Base) are used, the 7912AD becomes a fully programmable digitizer with a bandwidth of 200 MHz. This is a significant step toward fully automated test and measurement in disciplines such as laser and energy-related research, component or subassembly testing, and other areas requiring information extraction from high-speed waveforms.

CHARACTERISTICS

VERTICAL SYSTEM

Channels — Single plug-in compartment accepts any 7000 Series amplifier plug-in. Fully programmable when 7A16P is used.

Bandwidth (Determined by Amplifier Plug-in) — 7A16P: 200 MHz. 7A19: 500 MHz.

Delay Line — Permits viewing of leading edge of acquired waveform.

HORIZONTAL SYSTEM

Channels — Single plug-in compartment accepts any 7000 Series time base. Fully programmable with 7B90P.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B90P or 7B92A Time Bases.

Slowest Recommended Sweep Rate — 1 ms/div in Digital mode.

DIGITIZING AND STORAGE

Method — Scan conversion.

Resolution — Nine bits. In the Digital mode, the target is scanned in a 512 x 512 point matrix offering at least 400 discrete horizontal elements, each with a range of at least 320 discrete vertical values. In the TV mode, the target is scanned in a standard TV format with a resolution of at least 400 lines at 50% response.

Writing Rate (+10°C to +40°C) — TV Mode: Writes an 8 div sinewave of at least 500 MHz in a single sweep. Digital Mode: Stores a single 8 div pulse with a risetime of 1 ns or less.

Target Defects — No more than six points digitized other than those written by input waveform. Built-in firmware allows for defect removal by an external controller.

Memory — Type: Semiconductor. Size: 4096 10-bit words for data from target and two 512 16-bit word areas for internally processed and reduced data. Record Length: 512 samples/waveform maximum.

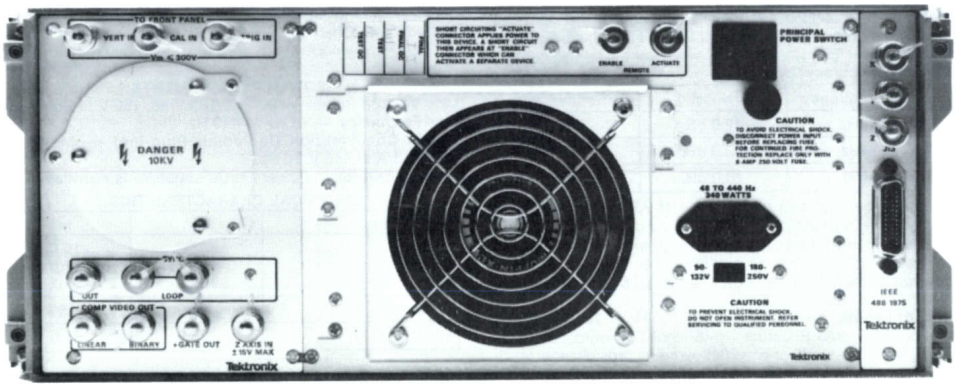
ELECTRONIC GRATICULE

8 x 10 div dot matrix written onto the scan converter target immediately after waveform acquisition. Can be displayed simultaneously with the input signal on the TV monitor or digitized and stored.

OUTPUTS/INPUTS

X, Y, Z Analog Output — Provides for analog display of data in memory. X and Y level is 1 V p-p into 100 kΩ or greater; adjustable from 0.75 V to 1.3 V. Z level is 0 to 1 V (full white) into 100 kΩ or greater.

Composite Video Output — Only available in TV mode. Used to drive a TV monitor for displaying signal written on scan-converter target as an aid to setting intensity for complete digitizing. Linear Output: Replica of the signal read from the target with sync added. Binary Output: Two-level output derived from the linear composite video output. Used to indicate on the TV monitor how well a waveform will be digitized. Scale factor readout included in both linear and binary.



Sync Output — At least 4 V into 75 Ω. Conforms to EIA RS-170.

Sync Loop — Allows TV mode to be synchronized with external EIA RS-170 sync waveform.

+Gate Output — Provides a positive pulse with a duration equal to and coincident with the time base sweep.

Z-Axis Input — ±1 V input modulates the writing gun intensity over its full range.

Vert In, Cal In, Trig In — Three internal 50 Ω coaxial cables connect signals from the rear panel to the front panel to ease system configuration in rackmounts.

Probe Power — Provides power for Tektronix active probes.

GPIB INTERFACE

Standard — Conforms to IEEE Standard 488-1975.

Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
TE6	Extended talker function
LE4	Extended listener function
SR1	Complete service request capability
RL1	Complete remote/local function
PP0	No parallel poll
DC1	Complete device clear capability
C0	No controller function
DT1	Device trigger complete

ENVIRONMENTAL

Temperature Range — Operating: 0°C to +40°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: Up to 4600 m (15,000 ft). Nonoperating: Up to 15 000 m (50,000 ft).

EMC (plug-ins inserted) — Meets MIL-STD-461A and 462 radiated and conducted interference from 30 Hz to 1 GHz.

POWER REQUIREMENTS

Line Voltage Range — 90 V to 132 V ac and 180 V to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Power Consumption (Including Plug-ins) — 360 W maximum.

Remote Control — Remote power On/Off capabilities provided.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	178	7.0
Length	679	26.8
Weight	**kg**	**lb**
Net	24.7	54.6

INCLUDED ACCESSORIES

Power cord (161-0066-00); set of rack slides (351-0375-01); GPIB cables (012-0630-03); instruction manual.

7A16P

Fully Programmable Plug-in for 7912AD or 7612D Digitizers Only

10 mV/div to 5 V/div Calibrated Deflection Factors

200 MHz Bandwidth (7900 Family)

50 Ω or 1 MΩ Input Selectable

The 7A16P is designed for use in Tektronix 7000 Series programmable digitizers. All of the normal operational features of a high-quality, wide-band 7000 Series plug-in amplifier are provided in the 7A16P. These are available at the front panel for manual selection, or they can be set under program control via a programmable mainframe and the GPIB.

Whether operated manually or under program control, the front-panel push buttons light to indicate plug-in status. Plug-in status can also be read over the GPIB by an external controller for input to instrument setup and control routines.

Two switch selected input connectors are also provided for selecting input signal source.

CHARACTERISTICS

Bandwidth — Plug-in Only: 225 MHz. With the 7912AD: 200 MHz. Bandwidth may be limited to 20 MHz ±3 MHz by bandwidth limit switch.

Ac Coupled Lower Bandwidth — 10 Hz or less.

Step Response — 50 Ω input plug-in only, 1.8 ns risetime.

Deflection Factor — 10 mV/div to 5 V/div, 9 steps in a 1-2-5 sequence. Accuracy is ±2% of indicated deflection factor with Gain adjusted at 10 mV/div. Uncalibrated variable is continuous between steps and extends selected deflection factor to at least 2.5 times the calibrated value.

Input R and C — Selectable: 1 MΩ within 2% and paralleled by ≈20 pF or 50 Ω ±1 Ω with vswr ≤1.5:1 at 200 MHz or less.

Inputs — Selectable A or B signal input connectors.

Maximum Input Voltage — 1 MΩ, Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 1 MΩ, Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 50 Ω: 0.5 W maximum.

Programmable Functions — All functions except Variable, Gain, and Identify are programmable.

Included Accessory — Instruction manual.

7B90P

500 ps/div to 500 ms/div Calibrated Time Base

Fully Programmable Plug-in 7912AD Digitizer Only

400 MHz Trigger Bandwidth

Single-Sweep Operation

The programmable 7B90P is designed for use with a Tektronix 7912AD Programmable Digitizer. Its operating functions can be manually selected at the front panel or selected under program control via the GPIB. The only nonprogrammable functions are the Sweep Calibration adjustment and the External Trigger Input Terminator Switch.

CHARACTERISTICS

Sweep Rates — 500 ms/div to 10 ns/div in 24 steps. Magnifier extends fastest calibrated sweep rate to 500 ps/div.

Sweep Accuracy — Measured over center 8 div, +15°C to +35°C, with any 7000 Series programmable mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div	Unmagnified	Magnified
500 ms/div to 100 ns/div	2%	3%
50 ns/div to 10 ns/div	3%	4%
500 ps/div	—	5%

Trigger Holdoff — Programmable in 62 steps between minimum and maximum.

Time/Div	Min (ccw)	Max (cw)
500 ps/div to 2 μs/div	≤3.5 μs	≥90 μs
5 μs/div to 20 μs/div	≤35 μs	≥900 μs
50 μs/div to 200 μs/div	≤350 μs	≥9 ms
500 μs/div to 2 ms/div	≤3.5 ms	≥90 ms
5 ms/div to 500 ms/div	≤35 ms	≥900 ms

Triggering Sensitivity

P-P AUTO MODE

Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
At least 50 Hz	2.0 div	500 mV
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 400 MHz	1.5 div	375 mV

NORM MODE

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext*1
Ac	30 Hz to 50 MHz	0.3 div	100 mV
	50 MHz to 400 MHz	1.5 div	250 mV
Ac LF Rej*2	30 kHz to 50 MHz	0.3 div	100 mV
	50 MHz to 400 MHz	1.5 div	250 mV
Ac HF Rej*3	30 Hz to 50 kHz	0.3 div	100 mV
Dc	Dc to 50 MHz	0.3 div	100 mV
	50 MHz to 400 MHz	1.5 div	250 mV

*1 *Ext ÷ 10 operation attenuates ext trigger signal 10 times.*
*2 *Will not trigger on sinewaves or <8 div Internal, or 3 V External, at or below 60 Hz.*
*3 *Will not trigger on 50 MHz sinewaves 1.5 div or less Internal, or 0.15 V or less External.*

Single-Sweep Mode — Same as Norm mode.

Trigger Level — Programmable in 0.05 div steps.

Horizontal Position — Programmable in 0.0125 div step unmagnified, 0.125 div step magnified.

Internal Trigger Jitter — 0.1 ns or less at 400 MHz.

External Trigger Input — Selectable: 1 MΩ ±5%, 20 pF ±10% or 50 Ω ±5% with 1.22 maximum vswr at 400 MHz. Maximum input is 250 V (dc + peak ac) for 1 MΩ or 1 W for 50 Ω. The level range (excluding p-p Auto) for a 1 kHz sinewave input is at least ±3 V in Ext and at least ±30 V in Ext ÷ 10.

Included Accessory — Instruction manual.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

It is recommended that 7912ADs not be purchased or operated without an accompanying Tektronix 634 Raster Scan Display Monitor (see page 141).

7912AD Programmable Digitizer **$26,300**

Option 13 — Change TV Scan to 625 lines at 50 Hz ..... **NC**

Option 30 — Delete GPIB Cable ..... **−$90**

634 Raster Scan Display Monitor **$2,900**

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

7A16P Programmable Amplifier **$2,330**

7B90P Programmable Time Base **$2,810**

SYSTEMS

The 7912AD is also available in WP2000 Series signal processing systems. These fully automatic systems are designed, assembled, tested, and documented to satisfy the demand for speed, automation, accuracy, and repeatability in characterizing devices or phenomena which give rise to waveforms in the millisecond to nanosecond range. For more information on these systems contact your local Tektronix Sales Engineer.

Tektronix offers service training classes on the 7912AD Programmable Transient Waveform Digitizer. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.

GPIB IEEE-488 **5223**

The 5223 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Digital Storage (with 5B25N)

10 MHz Bandwidth Repetitive Store

100 kHz Bandwidth Single Shot Store

Pretrigger

10 Bit Vertical Resolution

Stored X Versus Y Display

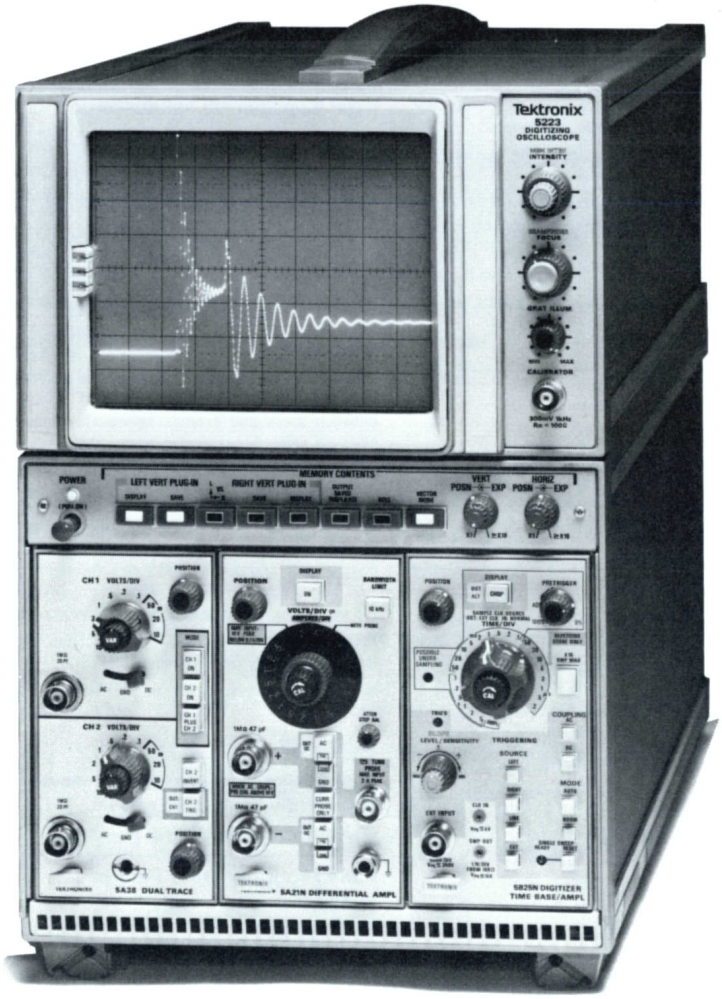
Roll Mode

X-Y Plotter Output with Penlift

APPLICATIONS

* **Mechanical Transducers**
* **Biophysical**
* **GPIB**

The Tektronix 5223 Digitizing Oscilloscope is a digital storage instrument with a real-time bandwidth of 10 MHz. The 5223 is capable of displaying real-time and stored waveforms simultaneously (four real-time waveforms and four stored waveforms, if dual channel amplifier units are used); the real-time waveforms need not be related to the stored waveforms. Stored waveforms can be expanded vertically and horizontally up to a factor of ten, using front-panel controls. The left and right stored vertical signals can be displayed against each other in the X-Y mode, using the L vs R front-panel display function. The roll mode is useful when viewing low frequency signals. Rear-panel connectors provide access to the internal analog and control signals to record stored waveforms using associated equipment (e.g., X-Y plotter). The 5223 accepts most 5000 Series plug-in units; the flexibility of the plug-in feature, and variety of plug-in units available, allows the system to be used for many measurement applications. The digital storage functions can only be accessed or enabled by using the 5B25N Time Base.



Display and Save Functions

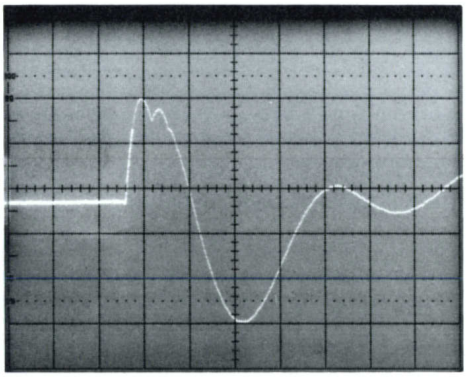
The Display buttons allow the 5223 to digitize the signals originating from the corresponding vertical compartments (left and right). The digitized display is continuously updated as long as a triggered sweep occurs, or until the Save button is pushed. The Save buttons freeze the memory contents. Up to four channels may be displayed and saved simultaneously.

L vs R Display

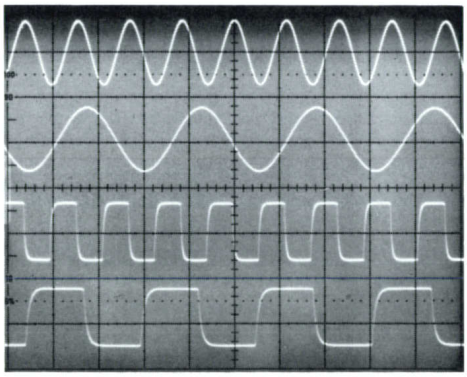
This function will display the memory contents of the left compartment versus the right compartment. The left defines the vertical axis and the right compartment defines the horizontal axis. Since the X-Y display is from memory, the real-time sweep is still in the standard Y-time format and may be displayed simultaneously.

Roll Mode Display

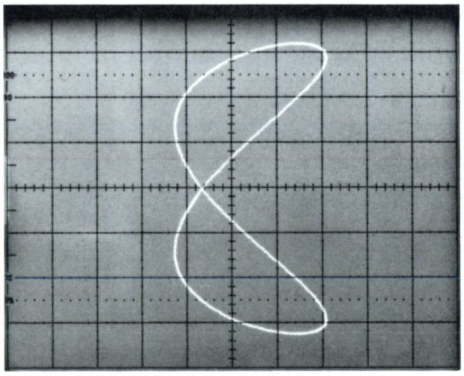
For continuous data stream monitoring of biomedical or low frequency events, the Roll mode digitizes the signal and displays the latest acquired point at the right of the CRT while the previous data moves from right to left. The display appears much like a strip chart recorder. Roll mode is available on the sweep range of 5 s/div to 0.1 s/div.



Single-shot data can be captured and stored automatically without the operator's presence. Pretrigger signal portion has an intensified trace for easy reference.



Up to four channels may be stored at a time either Single Shot or Repetitive.



By pressing the L vs R button, the memory contents of one vertical compartment are displayed against that of the other.

Vector Display
When Vector Display is selected, a continuous trace connects the discrete data points into a clear and comprehensive display. This eliminates perception problems of scattered data and reduces interpretation errors.

Output Saved Displays
When pressed, an analog output of the displayed/saved waveforms is activated for driving conventional X-Y analog plotters. Pen lift is also provided and is activated before and after each waveform is output. Up to four waveforms may be output.

Display Out Speed Control (Rear Panel)
The Display Out Speed control adjusts the X-Y plotter output speed to compensate for differences in plotter speeds and response.

CHARACTERISTICS

VERTICAL REAL TIME SYSTEM
Channels — Two plug-in compartments; compatible with 5000 Series plug-ins.

Mainframe Bandwidth — 10 MHz with 5A38, 5A45 or 5A48.

Mainframe Step Response — 35 ns.

Chop Mode — 100 chopped segments/div unexpanded with 5B25N Time Base.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL REAL TIME SYSTEM
Channel — Single compartment compatible with 5000 Series time bases and amplifiers. 5B25N must be used in storage modes.

Fastest Calibrated Sweep Rate — 20 ns/div.

X-Y Mode — <2° phase shift, dc to 20 kHz between either vertical compartment and horizontal compartment.

DIGITAL STORAGE (with 5B25N)
Vertical Resolution — 10 bits (100 pts/div unexpanded).

Display Memory Size — 1 k points/vertical compartment, shared by multiple trace plug-ins.

Sample Rate — Maximum of 1 μs/pt (1 MS/s). Actual sample rate depends on time base setting.

Fastest Single Shot Sweep Speed — 100 μs/div.

External Clock In — Max of 1 MS/s (1 μs/pt). TTL compatible.

Equivalent Time Bandwidth — 10 MHz.

Acquisition Window — ±4 div vertically and ±5 div horizontally from center screen.

Accuracy — Determined by plug-ins. Refer to plug-in specifications.

X-Y — (Left vs right single channel mode only excluding 100 μs/div sweep range). Maximum of 5° phase shift between vertical compartments up to 10 MHz using two identical 5400 Series vertical plug-ins.

MEMORY CONTROLS
Display and Save — Controls for each vertical compartment. X-Y (left vs right), Data Out, Roll, Vector mode, Horizontal and Vertical positioning, and expansion (≥10:1).

Data Out — Analog voltage of stored signal. 200 mV/div ±5%. Output rate variable with rear panel control. Pen lift available on rear panel (normally open).

OUTPUT/INPUTS
Plug-in Signal Outputs — Left, Right Vertical, Horizontal Compartments: 50 mV/div ±5% from 50 Ω. Left, Right Vertical Compartments: Dc ≥10 MHz. Horizontal Compartment: Dc ≥7 MHz.

Time Base Gate — TTL compatible, positive going.

Remote Single Sweep Reset — Rear panel BNC closure to ground resets sweep.

External Z-Axis Input — Usable, dc ≥5 MHz voltage swing of 5 V will fully modulate beam dc ≥1 MHz. Negative voltage will blank trace. Maximum input voltage is 40 V (dc + peak ac).

Calibrator — Voltage Output: Squarewave, positive going from ground. Amplitude is 300 mV ±1%. Current Output: 3 mA ±1% available through calibrator output with optional BNC to current loop adaptor.

CRT AND DISPLAY FEATURES
CRT — 8 x 10 div with 1.22 cm/div. Internal illuminated graticule.

Phosphor — GH (P31) standard.

Acceleration Potential — 15 kV.

Camera Power — Compatible with Tektronix C-59 Camera.

POWER REQUIREMENTS
Line Voltage Range — 90 v to 117 V, 102 v to 132 V, 191 V to 249 V, 204 V to 250 V maximum.

Line Frequency — 48 Hz to 62 Hz (48 Hz to 440 Hz, Option 05).

Maximum Power Consumption — 145 W at 120 V, 60 Hz.

OPTIONS
Option 05 Line Frequency Change (48 Hz to 440 Hz) — Converts the R5223 to 48 Hz to 440 Hz operation.

Option 10 GPIB Interface — For I/O of stored waveforms and control of 5223 digital storage functions (except vertical and horizontal expansion and position controls). Waveform output format is selectable through the interface for BINARY or ASCII.

The Tektronix 4932 GPIB Extender provides a cost-effective way to interconnect remotely located GPIB instruments, allowing communication at distances of up to 500 meters (1650 feet).

I/O Records — Waveforms.

Device Address — Selectable via rear panel switch.

Talk/Listen — Full bi-direction transfer of waveforms plus remote manipulation of storage controls.

Talk Only — Continuous output of digitized waveform to maximum sweep of 20 ms/div (dependent on other instruments on bus).

Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
T5	Talker function
L4	Listener function
SR1	Complete service request capability
RL2	Remote/local capability
DC1	Complete device clear capability

PLUG-IN COMPATIBILITY
All 5000 Series plug-ins are compatible in the standard oscilloscope display mode. The 5L4N, 5A18N, 5A26, 5A48 plug-ins may require modification for optimum use with digital storage operation. The 5A14N is not recommended for use in storage mode.

Included Accessory — Instruction manual.

5B25N Digital Time Base

Bi-Slope Triggering

20 ns/div to 5 s/div Calibrated Time Base

Triggering to 15 MHz

The 5B25N is designed specifically for use in the 5223 Digital Storage Oscilloscope. Pretrigger is only available with the 5223. However, the standard analog sweep features including Bi-Slope Triggering and X10 Mag are compatible with 5400 Series mainframes.

CHARACTERISTICS

Modes — Auto, Normal, Single Sweep.

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

External Trigger Input — Maximum input voltage is 350 V-peak. Input R and C is 1 MΩ paralleled by ≈24 pF.

External Horizontal Input — Deflection factor is 50 mV/div ±3%. Dc coupled bandwidth is dc to 2 MHz.

Sweep Rate — 0.2 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 20 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

TRIGGERING

Slope	Frequency Range	Minimum Signal Required: Internal	Minimum Signal Required: External
+ or −	Dc to 1 MHz 1 MHz to 15 MHz	0.4 div 0.6 div	50 mV 200 mV
± (Bi-Slope)	Dc*1 to 1 MHz	±0.5 div	±50 mV

*1 30 Hz when ac coupled.

Bislope Triggering — Will trigger on either a positive or negative slope and the threshold or sensitivity is controlled by the trigger level knob. This eliminates the uncertainty of which slope is selected.

CHARACTERISTICS
(WHEN USED WITH THE 5223 MAINFRAME)

Accuracy

Time/Div	Sweep*1	Digitized*2	Digitized to Real Time*3
50 μs/div to 0.2 μs/div	3%	3%	3%
1 s/div to 0.1 ms/div	3%	3%	3%
2 s/div and 5 s/div	4%	3%	4%

*1 *Accuracy is specified over the center 8 graticule divisions, in 5223 or 5400 Series oscilloscopes. Derate accuracy by 1% for 0° C to +50° C, or when using X10 magnifier.*

*2 *Digitized signal accuracy is specified over center 8 graticule divisions in 5223 Oscilloscope, excluding first 200 ns or 0.2 div of each waveform.*

*3 *The digitized signal will match the real time signal within the specified tolerance.*

Pretrigger — For viewing events that occur prior to the trigger and is continuously variable from 0% to 100% of full screen. An intensified zone is generated which corresponds to the amount of pretrigger selected. This intensified zone remains with the saved waveform. Pretrigger is available from 5 s/div to 0.1 ms/div.

Possible Undersampling Indicator — To aid in eliminating aliasing, an LED indicator illuminates when the ratio of sampling frequency to trigger frequency is less than eight.

Sampling Rate — For single shot acquisition, the 5B25N has a maximum sample rate of 1 MHz at 0.1 ms/div.

Repetitive Store — For repetitive signals, the 5B25N controls the equivalent time sampling feature of the 5223 to allow digitizing from 50 μs/div to 0.2 μs/div.

External Clock Input — Clock-In pin jack allows the user to introduce an external sampling clock. Maximum input frequency of 1 MHz, with TTL threshold, and 5 V peak input voltage.

Included Accessory — Instruction manual.

ORDERING INFORMATION

5223 Digitizing Oscilloscope **$5,080**

R5223 Rackmount **$5,230**

Option 05 — Line Freq Change (R5223 Only) ..... **+$200**

Option 10 — GPIB Interface ..... **+$750**

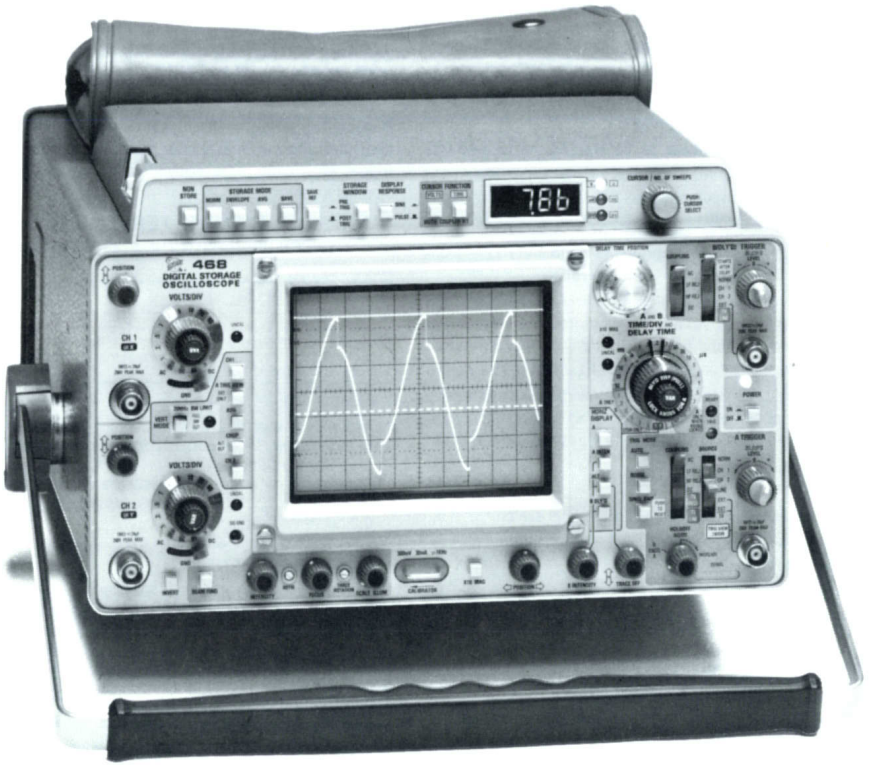
CONVERSION KITS
Rackmount-to-Cabinet —
Order 040-0975-01 ..... **$230**

Cabinet-to-Rackmount —
Order 040-0976-04 ..... **$315**

INTERNATIONAL POWER CORD AND PLUG OPTIONS
Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

5B25N Time Base **$845**

4932 GPIB Extender (see page 132) .. **$1,195**



GPIB IEEE-488

468/R468

The 468 and R468 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

10 MHz Useful Storage Bandwidth

Cursors for Time and Voltage Measurements

Signal Averaging

Envelope Mode (Patented)

GPIB Option

100 MHz Nonstorage Bandwidth

Advancing the state-of-the-art in digital storage oscilloscopes is the Tektronix 468. This high performance portable scope is capable of accurately storing and displaying 10 MHz single shot events using a unique display interpolation system.

The 468 was designed with many features which enhance its usefulness in your applications. Cursors and a calibrated LED readout enable you to measure time or voltage differences easily and accurately.

Signal Averaging, now standard on the 468, can be used to remove random noise from a signal and improve measurement accuracy.

The Envelope mode, (patented), uses multiple sampling rates and digital memory to capture and record the maximum and minimum excursions of a waveform. The resulting waveform "envelope" can be used to catch glitches, view frequency drift and amplitude modulation, or detect aliasing. Unlimited storage time, expandable, repositionable stored traces; Save Reference memory; pretrigger viewing; and correction for the trigger uncertainty inherent in digital storage make the 468 the most versatile digital storage scope available today.

Option 02 provides a GPIB interface (talk only). This transmits stored waveforms and scale factor information to a listener or controller.

Other options include a TV sync separator, EMC shielding, X-Y recorder output.

CHARACTERISTICS

DIGITIZER, MEMORY

Speed — Digitizing rates from 10 samples/s at 5 s/div to 25 mega-samples/s at 2 μs/div and faster. Digitizing rate changes proportionate to sweep speed (50 data words/horizontal div). Chopped mode effectively halves the digitizing rate/waveform.

Resolution — Eight bit (one part in 256) vertical resolution.

Memory Size — Up to two 512-word waveforms or four 256-word waveforms can be stored and displayed.

Interpolator — Two firmware interpolators; one optimized for sine waveforms, one optimized for pulse waveforms.

VERTICAL DEFLECTION
(2 IDENTICAL CHANNELS)

Bandwidth and Risetime[*1]

Storage Modes[*2]

Display Response	Bandwidth	Risetime
Sine	10 MHz	NA
Pulse	3.5 MHz	64 ns

Nonstore Modes[*3]

Temperature Range	Bandwidth	Risetime
−15°C to +40°C	DC to 100 MHz	3.5 ns
+45°C to +55°C	85 MHz	4.1 ns

*[*1] At all deflection factors from 50 Ω terminated source.*

*[*2] Bandwidth measured at 5% envelope error and maximum sampling rate, using appropriate interpolator. Risetime is 1.6 times minimum sample interval. Chopped mode halves the bandwidth.*

*[*3] Measured at −3 dB. Bandwidth may be limited to ≈20 MHz by bandwidth limit switch.*

Cascaded bandwidth is at least 50 MHz when signal out is terminated in 50 Ω.

Lower −3 dB point. Ac Coupling 1X Probe: 10 Hz or less. 10X Probe: 1 Hz or less.

Deflection Factor at Bandwidth — Storage Modes: 0.5 mV/div to 5 V/div. Nonstore Modes: 5 mV/div to 5 V/div. 1-2-5 sequence, accuracy is ±3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. In cascade mode sensitivity is ≈1 mV/div. Stored images can be expanded by factor of 10 vertically.

Display Modes — CH 1; CH 2 Add (normal and inverted), Trigger View (nonstore only). Alternate, Chopped: ≈250 kHz rate, in any combination electronically switched in nonstore; in storage chop rate is ½ the digitizing rate.

Envelope Mode — Records waveform envelope over multiple sweeps. 5 MHz digitizing rate from 5 sec/div to 10 μs/div; 10 MHz digitizing at 5 μs/div; 25 MHz digitizing from 2 μs/div and faster. Number of sweeps equals 1 to 256 plus continuous setting.

Signal Averaging — 2 to 256 sweeps can be averaged together to remove random noise.

Common-Mode Rejection Ratio — At least 20 dB at 20 MHz (10 MHz in storage) for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All LEDs are off when the channel is not displayed.

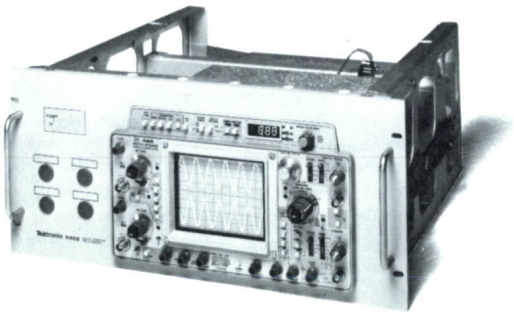
Ground Reference Display — In storage modes moving the coupling selector to ground position will locate ground and display a reference dot at left edge of CRT.

Input R and C — 1 MΩ ±2% paralleled by ≈20 pF.

Maximum Input Voltage

Dc coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

Delay Line — Permits viewing leading edge of displayed waveform.



R468 Rackmount

HORIZONTAL DEFLECTION

Time Base A — 0.02 μs/div to 5.0 s/div (0.5 s/div in nonstore mode) in a 1-2-5 sequence. X10 magnifier extends maximum sweep rate to 2 ns/div.

Time Base B — 0.02 μs/div to 5.0 s/div (50 ms/div in nonstore mode) in a 1-2-5 sequence. X10 magnifier extends maximum sweep rate to 2 ns/div.

Variable Time Control — In storage modes has no effect. In nonstore mode Time Base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div LED warning light indicates uncalibrated setting.

Time Base Accuracy — Full 10 cm Storage Modes 0.1%.

Nonstorage Mode

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

Horizontal Display Modes

Storage: A, B delayed.

Nonstorage: A, A intensified, alternate, B delayed. B ends A for increased intensity in the delayed mode. Electronic switching between intensified and delayed sweep. A sweep and B sweep may be viewed simultaneously.

CALIBRATED SWEEP DELAY

Delay Time Range — 0.2 to X10 delay time/div settings of 200 ns to 0.5 s.

Differential Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C
Over one or more major dial div	±1%
<1 major dial div ±0.01 major dial div	

Jitter — One part or less in 50,000 (0.002%) of 10X the A sweep time/div setting. One part in 20,000 (0.005%) when operating from 50 Hz line.

TRIGGERING A AND B

A Trigger Modes — Normal (sweep runs when triggered). Automatic (sweep runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). LED lights indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff (Nonstore Only) — Adjustable control permits a stable presentation of repetitive complex waveforms.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B delayed sweep runs once, in each of these modes, following the A sweep delay time.

Storage Trigger Positions — Posttrigger Point: 1.25 div. Pretrigger: 8.75 div.

Time Base A and B Trigger Sensitivity and Coupling

Coupling	To 25 MHz	At 100 MHz
Dc Internal	0.3 div deflection	1.5 div deflection
Dc External	50 mV	150 mV
Dc External ÷ 10	500 mV	1.5 V
Ac	Requirements increase below 60 Hz	
Ac LF Reject	Requirements increase below 50 kHz	
Ac HF Reject	Requirements increase below 60 Hz and above 50 kHz	

Digital Storage Jitter — 0.5 ns or less at 100 MHz and 2 ns/div.

Digital Trigger Uncertainty — Correction circuit for the ±½ sample interval trigger uncertainty that is caused by asynchronous trigger/sample clock relationship.

A Trigger View (Nonstore Mode Only) — Electronically switched trigger view displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal which can be displayed simultaneously. The deflection factor is ≈100 mV/div (1 V/div with external ÷10).

Level and Slope — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. External: Through at least ±2 V. External ÷10: Through at least ±20 V.

A Sources — Normal, CH 1, CH 2, Line, Ext, and Ext ÷10.

B Sources — Starts after delay, Normal, CH 1, CH 2, and External.

External Inputs — R and C ≈1 MΩ paralleled by ≈20 pF. 250 V (dc + peak ac) maximum input.

X-Y OPERATION

Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical) — 5 mV/div to 5 V/div, accuracy is ±4%. Bandwidth is dc to at least 4 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz. Nonstore mode only.

DISPLAY

CRT — 8 x 10 cm display. Horizontal and vertical centerlines further marked in 0.2 cm increments. GH (P31) Phosphor standard; BE (P11) optional. 18 kV accelerating potential.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an offscreen signal. A preset intensity level provides a constant brightness.

Z-Axis Input — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz. Nonstore mode only.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C. Filtered forced air ventilation is provided.

Altitude — Operating: To 4600 m (15,000 ft). Maximum allowable ambient temperature decreased by 1°C/1000 ft from 5,000 to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (four g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in one minute cycles.

Humidity — Operating and Nonoperating: Five cycles (120 hours) to 95% relative humidity as specified in MIL-T-28800B (par 3.9.2.2).

Shock — Operating and Nonoperating: 30 g's ½ sine, 11 ms duration, three shocks/axis in each direction for a total of 18 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 V	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	≈ 1 kHz	

Vertical Signal Output — CH 1 vertical signal is dc to at least 50 MHz (−3 dB) and ≈25 mV/div terminated into 50 Ω, and ≈50 mV/div terminated into 1 MΩ.

Gate Outputs — Positive gates from both time bases (≈5 V).

Power Requirements — Quick change line voltage selector provides four ranges to cover 90 V to 132 V and 198 V to 250 V. 48 Hz to 440 Hz, 150 W maximum at 115 V and 60 Hz.

PHYSICAL CHARACTERISTICS

Dimensions (468)	mm	in
Width (with handle)	328	12.9
Height (with feet & pouch)	191	7.5
Depth (with panel cover)	550	21.7
Depth (handle extended)	600	23.6
Weights ≈ (468)	**kg**	**lb**
Net (without panel cover)	13.6	30.0
Net (with panel cover and accessories)	15.0	33.0
Shipping	21.7	47.0
Dimensions (R468)	**mm**	**in**
Width	483	19.0
Height	223	8.8
Depth	553	21.8
Weights	**kg**	**lb**
Net	18.6	41.0
Shipping	25.5	56.0

INCLUDED ACCESSORIES

Two P6105 10X probes (010-6105-03), blue accessory pouch (016-0594-00), clear pouch (016-0537-00), blue CRT light filter (337-1674-00), clear CRT light filter (337-1674-01), ground wire (134-0016-01), two 1½-amp fuses (159-0016-00), one ¾-amp fuse (159-0042-00); instruction manual.

ORDERING INFORMATION

468 Storage Oscilloscope **$6,500**

R468 Rackmount Storage Oscilloscope **$6,775**

INSTRUMENT OPTIONS

Option 02 — For 468. GPIB Interface follows Tektronix *Standard Codes and Formats* ..... **+$860**

Option 02 — For R468. GPIB Interface follows Tektronix *Standard Codes and Formats* ..... **+$905**

Option 04 — EMC Environmental ..... **+$180**

Option 05 — TV Sync Separator (Provides triggering on TV field and line) ..... **+$350**

Option 11 — For 468. X-Y Recorder Output (Not compatible with Option 02) ..... **+$525**

Option 11 — For R468. X-Y Recorder Output (Not compatible with Option 02) ..... **+$550**

Modification kits, for field conversion of existing 468s to Option 02, are available. These typically cost more than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, Distributor, or Representative for information.

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A4 — North American 240 V/15 A, 60 Hz
Option A5 — Switzerland 220 V/10 A, 50 Hz

OPTIONAL ACCESSORIES

Service ROM — This provides service and signature analysis routines for verification and troubleshooting the digital portion of the instrument. Recommended to be used with a Tektronix 308 Data Analyzer. Order 067-0989-00 ..... **$85**

Probes

Probe Type	Attenuation	Input Impedance	Bandwidth*1
P6063B 6 ft	1X	1 MΩ 105 pF	6 MHz
	Switchable		
	10X	10 MΩ 14pF	90 MHz
P6202A 2 m FET Probe	10X	10 MΩ 2 pF	100 MHz
	100X Head	10 MΩ 2 pF	100 MHz
	Ac Head	10 MΩ 4 pF	100 MHz
Current Probe	**Calibration**	**Insertion Impedance**	
P6022 5 ft	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω at 1 MHz Increasing to 0.2 Ω @ 120 MHz	85 MHz

**1 Nonstore modes — Bandwidths are measured at the upper −3 dB and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.*

Folding Polarized Viewing Hood
Order 016-0180-00 ..... **$40**

Collapsible Viewing Hood — Binocular.
Order 016-0566-00 ..... **$15**

Protective Cover — Waterproof, blue vinyl.
Order 016-0365-00 ..... **$21**

Mesh Filter — Improves contrast and EMC filtering.
Order 378-0726-01 ..... **$55**

SCOPE-MOBILE® Cart — Occupies <18 in aisle space, has storage area in base. Order 200D or 200C **$320**

1105 Battery Power Supply **$1,430**

Rack Adaptor Order 016-0675-00 ..... **$325**

RECOMMENDED CAMERA

C-30BP Option 01 — General Purpose Compact Camera Includes 016-0301-00 mounting adaptor/corrector lens.
Order C-30BP Option 01 ..... **$1,417**

For further information see camera section.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect (503) 627-9000, Ext 99.

SONY®/TEKTRONIX® 50 MHz DUAL TRACE DIGITAL STORAGE OSCILLOSCOPE

NEW

GPIB IEEE-488

336

The 336 with Option 01 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

1 MS/s, 140 kHz Useful Storage Bandwidth

Cursors for Time and Voltage Measurements

Signal Averaging

Envelope Mode

GPIB and 8 Screen Memory Option (16 k)

50 MHz Nonstorage Bandwidth

CRT Readout

The SONY/TEKTRONIX 336 is a combination nonstorage and digital storage portable oscilloscope. It is capable of displaying analog and digitized waveforms simultaneously, and can store up to 18 digitized waveforms for recall and display. The 336 is a microprocessor controlled instrument that incorporates alphanumeric CRT readouts of the vertical and horizontal scale factors, the delay time position, and voltage and time readouts of the cursor positions. Many of the oscilloscope features and modes are chosen from a menu displayed on the CRT rather than from hard-wired front-panel switches. Also included is an Auto mode for both vertical volts per division and horizontal time per division, allowing "hands off" operation in many applications.

The 336 has a dual-channel, dc-to-50 MHz vertical deflection system for both nonstorage and equivalent-time digitizing. Storage bandwidth for single sweep events (waveforms acquired as the result of a single triggering event) is dc-to-140 kHz. The vertical channels have calibrated deflection factors from 5 mV to 10 V per division with a choice of either ac or dc input coupling. In the Nonstore mode, the 336 operates like a conventional oscilloscope.

GPIB (talker only) is optional on the 336. Included in the option is a memory backup of up to eight screens (two 1 k waveforms each) of information.

CHARACTERISTICS

DIGITIZER AND MEMORY

Speed — Digitizing rates up to 1 mega-sample/s.
Useful Storage Bandwidth — Real Time Sampling: Dc to 140 kHz (−3 dB). Equivalent Time Sampling: Dc to 50 MHz (−3 dB).
Resolution — Vertical: Eight bit. Horizontal: Ten bit.
Memory Size — Standard: 2 kbyte (one frame of two waveforms). Option 01: 16 kbyte (up to eight frames of two 1 k waveforms each storage capacity). Data Retention: At least 3 days (after 8 hrs of operation).

VIEW DISPLAY MODE

This is the saved "store" waveform (saved from Store display mode). Process functions are the same as Store display mode.

NONSTORED AND STORED DISPLAY MODES

The following characteristics apply to both modes unless otherwise indicated.

VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

Bandwidth and Risetime*[1]

0°C to +40°C	+40°C to +55°C
Dc to at least 50 MHz	Dc to at least 40 MHz

[1] At all deflection factors from a 50 Ω source.

Deflection Factor — Range: 5 mV/div to 10 V/div. Accuracy is ±3%. Uncalibrated, continuously variable between steps, and to at least 25 V/div.
Vertical Modes — Stored Mode: CH 1, CH 2, Chop, Dual and Trigger View. Nonstored Mode: CH 1, CH 2, Chop and Dual.
Normal Mode (Store Mode Only) — Acquired displayed signal.
Envelope Mode (Store Mode Only) — 1, 8, 16, 32, 64, 128, 256 sweeps, or continuous at s/div settings of 2 ms/div to 0.2 s/div.
Average Mode (Store Mode Only) — 8, 16, 32, 64, 128 or 256 sweep averages.
Process Mode (Store and View Mode Only) — Waveform: CH 1 + CH 2 is within 6%. CH 1 − CH 2 is within 6%. CH 1 × CH 2 is within 7%. Parameters (Selectable): RMS is within 3% + 6% of V/div setting. Mean is within 3% + 4% of V/div setting. P-P is within 3% + 4% of V/div setting. Store or view waveforms must acquire inital ground reference level.
Common-Mode Rejection Ratio — At least 10:1 at 10 MHz (5 MHz storage).
Input R and C — 1 MΩ ±2% paralleled by 33 pF.

HORIZONTAL DEFLECTION (NONSTORE MODE ONLY)

Time Base A — 0.2 s/div to 0.1 μs/div in a 1-2-5 sequence. X10 MAG extends the maximum sweep rate to 10 ns/div. (At sweep speeds slower than 0.2 s the scope automatically goes to Roll mode.)
Time Base B — 50 ms/div to 0.1 μs/div in a 1-2-5 sequence. X10 MAG extends the maximum sweep rate to 10 ns/div.
Variable Time Control — Continuously variable between calibrated settings of the A s/div switch. Extends the slowest sweep rate to at least 0.5 s/div.
Time Base Accuracy

	+20°C to +30°C	0°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

DIGITAL STORAGE HORIZONTAL ACQUISITION

Resolution — Ten bit. 1024 data points.
Range — Equivalent Time Sampling: 50 ns/div to 0.1 ms/div. Single Sweep Storage: 0.2 s/div to 0.1 ms/div. Roll Mode: 20 s/div to 0.5 s/div. Envelope Mode: 0.2 s/div to 2 ms/div.
Accuracy — 3% from +20°C to +30°C; 4% from 0°C to +55°C.
Horizontal Display Modes — Nonstore: A sweep, B delay, alternate, X-Y. Storage: A sweep, B delay, X-Y.

CALIBRATED SWEEP DELAY

Differential Time Measurement Accuracy (Nonstore Mode)

+15°C to +35°C	within 1% of indicated value
0°C to +55°C	within 2.5% of indicated value

Delay Time Jitter (Nonstore Mode) — 1 part or less in 10,000.
Delay Time Resolution (Store Mode) — 14 bit.
Cursor Accuracy (Store Mode) — ΔV: Within 3%. ΔT: Real time sampling is ±0.1% of full scale. Equivalent time sampling from +20°C to +30°C is ±3%; from 0°C to +55°C is ±4%.

TRIGGERING A AND B

A Trigger Modes — Normal: Sweep generator requires a trigger to generate a sweep. Automatic: Sweep generator free runs in the absence of a trigger. Single sweep: One sweep is initiated by the first trigger after reset.
Trigger Sources — Internal, CH 1, CH 2, composite or external.

Sensitivity and Coupling

Coupling	To 10 MHz	To 50 MHz
AL	0.3 div above 30 Hz	1.5 div
LF Rej	0.5 div above 50 kHz	1.5 div
HF Rej	0.5 div, 30 Hz to 50 kHz	——
Dc	0.3 div	1.5 div
External	70 mV	350 mV
TV	Stable video rejection and sync separation from sync-negative NTSC or PAL composite video	

Trigger Jitter — Nonstore Mode: 1 ns or less at 50 MHz. Storage Mode: ±1 sample period.
External Trigger View — Deflection Factor: Ext is 100 mV/div. Ext ÷ 10 is 1 V/div.
External Trigger Input — R and C = 1 MΩ paralleled by 33 pF (200 V dc + Peak ac) maximum input.
Acquisition Window Trigger Point — Pretrigger: 7/8 of waveform occurs before trigger point. Midtrigger: 1/2 of waveform occurs before trigger point. Posttrigger: 1/8 of waveform occurs before trigger point.

X-Y OPERATION (NONSTORE)

Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical) — 5 mV/div to 5 V/div with bandwidth of dc to 1 MHz. Phase difference is 3° from dc to 50 kHz.

DISPLAY

CRT — 8 x 10 div (0.6 cm/div) display GH (P31) Phosphor standard. 12 kV operating potential.
Graticule — Internal. Vertical and horizontal centerlines marked in 5 minor div/major 0.6 cm/div.
Z-Axis Input — Range +3 V to +25 V with 1 MHz useable frequency range. Input resistance of at least 10 kΩ.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Operating: 0°C to +55°C. Nonoperating: −25°C to +75°C.
Option 01: −20°C to +55°C.
Altitude — Operating: To 4600 m (15,000 ft). Decrease maximum operating temperatures 1°C for each 1000 ft above 5000 ft. Nonoperating: To 15 000 m (50,000 ft).
Vibration — 0.025 p-p (4 g's at 55 Hz) displacement, 15 minutes along each axis from 10 Hz to 55 Hz.
Humidity — 120 hrs of MIL STD 202D, minus freezing and vibration.
Shock — 30 g half sine, 11 ms duration on each axis.

OTHER CHARACTERISTICS

Chart Output — Clock Rate: Fast or slow. Amplitude: 500 mV/div. Output Impedance: 220 Ω.
Calibrator — Output Voltage: 0.3 V ±1%. Output Resistance: 5 Ω. Frequency: ≈1 kHz.
Ac Power Requirements — Line Voltage Ranges: 90 V to 132 V ac, 180 V to 250 V ac. Line Frequency: 48 Hz to 440 Hz. Power Consumption: 50 W maximum.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	237	9.3
Height	112	4.4
Depth (Handle Not Extended)	370	14.6
Depth (Handle Extended)	482	19.0
Weight	**kg**	**lb**
Net	5.0	11.1
Shipping	10.5	23.1

INCLUDED ACCESSORIES

Two 10X P6148 attentuator probes (010-6148-03); accessory pouch (016-0718-00); front panel cover (016-0719-00); CRT filter (378-0225-00); operator's and service manuals.

Order 336 Digital Storage Portable Oscilloscope **$4,500**

GPIB & MEMORY OPTION

Option 01 provides a GPIB interface (talk only). This transmits stored waveforms and scale factor information to a listener or controller. Extended waveform memory is included in this option. It will store 16 additional waveforms at 2 waveforms/screen, for 16 k total additional memory.

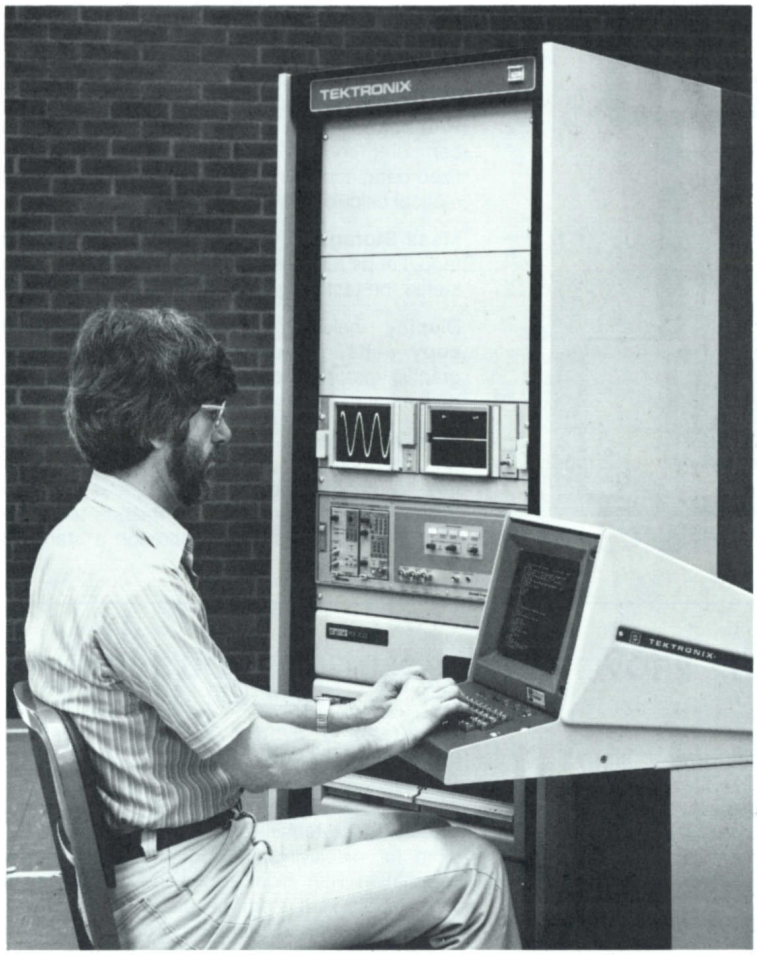
The SONY®/TEKTRONIX® 336 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 336 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

DIGITAL STORAGE SCOPE

SIGNAL PROCESSING SYSTEMS

CONTENTS

System Products 354
Software 355
Mini-Computer Based Systems 356
Desktop Computer Based Systems 357



Computer - Based 7912AD System

Desktop Computer - Based 7854 System

Precise automatic waveform measurements for demanding applications in research, design, manufacturing and quality assurance

Automatically save hours, days, even months of work

Tektronix Signal Processing Systems are specially designed to handle the increasingly complex, expensive, and time-consuming task of waveform characterization.

They're the first measurement systems to offer all the power and flexibility of oscilloscope acquisition, coupled with fully automatic analysis. They're the first systems to feature signal processing software with extensive control over instrumentation, waveform manipulations, and graphic display. And they're the first to provide system compatibility that allows configuration for many types of test and measurement applications.

With Tektronix Signal Processing Systems you concentrate on test results, not test procedures. There are no human-eye interpretations, hand processing, or complex statistical graphing. Tektronix Systems automatically capture the signals you need, make the measurements you want, then display, store, and document your solutions.

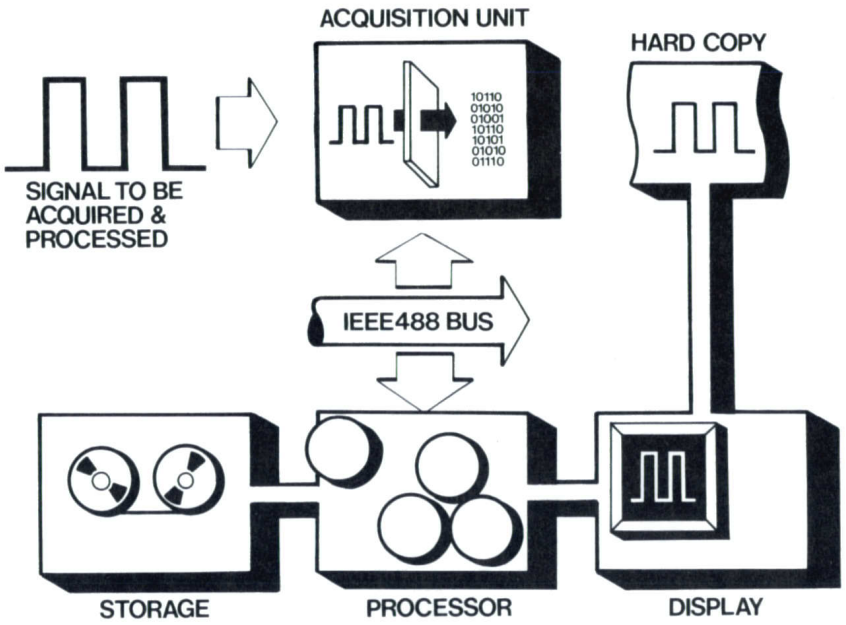
This means work that used to take hours, now takes only minutes. System automation saves you time and money by greatly increasing your productivity. Projects not only get completed on schedule, they get completed on budget.

Plus, system automation gives greater measurement accuracy and accountability on your finished product. Since there's less operator involvement in measurements, there's less chance of human error.

From today's research and development tasks to tomorrow's production testing, Tektronix Systems give you all the capabilities needed to characterize your waveforms quickly, efficiently, and automatically.

For measurement solutions you can't beat the SYSTEM.

SPS AUTOMATION . . .



FIVE MAJOR SYSTEM COMPONENTS AND TEK'S COMPREHENSIVE SOFTWARE MEET YOUR MEASUREMENT NEED

Acquisition, built around Tektronix GPIB Waveform Digitizers and 7000 Series oscilloscope plug-ins, captures analog data, converts and stores it in a digital format acceptable to the system processor.

Processor, either minicomputer or desk-top computer, controls the system, accepts the digitized data, and then performs the needed mathematical calculations and operations.

Mass Storage, in the form of disk or magnetic tape, keeps a log of the processed data and also stores the test programs.

Display, including graphic terminal and **hard copy units,** provides both alphanumeric and graphic presentation of data and permanent documentation.

Software, specially developed for ease of use with Tektronix Signal Processing Systems, controls all other system components and performs the desired computations. Commands are high-level BASIC and accessible through a standard terminal keyboard.

A WIDE RANGE OF SYSTEM PRODUCTS PROVIDES THE SOLUTIONS YOU NEED

Signal Acquisition — Fast or Slow, Transient or Repetitive

The growing family of GPIB compatible High Performance Waveform Digitizers provides a broad range of acquisition capabilities. They offer the ability to analyze signals ranging from seconds to picoseconds in duration, and risetimes to 25 ps. Plus, most are compatible with a broad range of 7000 Series Plug-ins.

7912AD*1

For high-speed transient signal acquisition, the 7912AD Programmable Digitizer has the capability to capture signals in the millisecond to subnanosecond range with a bandwidth of up to 1 GHz.

7612D*1

For medium-speed signals, the 7612D Programmable Digitizer offers dual channel acquisition, selectable sampling rates within records, and pre- and post-triggering. With the 7612D you can capture transient signals from seconds to submicroseconds in duration with high resolution.

7854*1

For fast, repetitive signals, the 7854 Oscilloscope is ideal when configured in a system. The 7854 features an on-board microprocessor. This instrument provides the system with the capability to acquire high speed signals with rise times to 25 ps.

**1 See Digitizers Section for details.*

390AD*1

For low to medium speed signals. The SONY/TEKTRONIX 390AD offers crystal-controlled 30-MHz sampling on two channels, or 60 MHz sampling on one channel. Features include cursor based measurements, sample rate switching, and direct plotter output capability.

System Controllers Dedicated to Speed and Precision

Tektronix Signal Processing Systems are divided into two major processor families: the minicomputer family, and the desktop computer family.

The Tektronix minicomputer systems, built around DEC PDP-11 compatible controllers, are designed to handle large amounts of data. They offer flexibility in peripheral selection, processing speed, and up to 128k words of memory space. Plus, the software support is specially developed for waveform manipulations, array processing and display efficiency.

The desktop computer systems are built around the 4052A Desktop Computer—one of the most powerful analytical performers available today. Its built-in extended BASIC software is complemented by special ROM packs featuring commands most often used in signal processing applications.

Wide-ranging System Peripherals for Full Documentation and Display

Tektronix Signal Processing Systems provide the best in display—the 4012 or the 4052A graphic screen. These terminals provide an excellent medium for displaying graphic and alphanumeric information with high resolution. In addition, a wide range of system peripherals is available, including graphic plotters, hard copy units, disk and magnetic tape storage devices.

Multiplexer 1360P/S*2

The 1360 is a microprocessor-based GPIB compatible system instrument that can be used to multiplex electrical signals at bandwidths up to 250 MHz. It includes two separate chassis: the 1360P Programmable Switch Controller and the 1360S Switch Matrix. Up to four 1360S Switch Matrix units may be operated by one 1360P. With one 1360S one may multiplex one output with 33 inputs, two ganged outputs with 17 inputs, or four ganged outputs with nine inputs. With four 1360S units these numbers increase so one may multiplex one output with 129 inputs, two ganged outputs with 65 inputs, or four ganged outputs with 33 inputs.

**2 See page 372 for details.*

Total Support

Complete details and application consultation is available through your local Tektronix Sales Office. Sales Engineers and Application Engineers stand ready to answer all your system questions.

The next logical step

ANY SYSTEM IS ONLY AS GOOD AS ITS SOFTWARE
SPS SYSTEMS OFFER THE BEST SOFTWARE AVAILABLE

TEK SPS BASIC is a comprehensive, general purpose programming language with enhancements for instrument control and waveform processing. Modular in design, it provides an optimum balance between flexibility, space efficiency, and computing power. Yet it retains the "easy-to-learn, easy-to-use, easy-to-remember" character of traditional BASICs. This makes it an ideal tool for beginning users as well as expert programmers.

TEK SPS BASIC runs on most of the Digital Equipment Corporation PDP Series of minicomputers. It consists of a Resident Monitor and an expandable library of over 100 non-resident commands. This lets you configure a software system to meet your unique measurement needs.

It's ready to use. TEK SPS BASIC requires a minimum system consisting of a controller with two hard-disk or two flexible-disk drives. Commands can be added to the system from the disk as needed to provide maximum space efficiency in available memory.

Named files can be accessed by TEK SPS BASIC on hard or flexible disk, or magnetic tape and information can be read from files either sequentially or randomly. BASIC commands give you complete file management capability. Files are compatible with DEC's RT11 operating system.

Comprehensive graphics permit waveform plots and X-Y plots between waveforms. Either can be done with single commands. The output is complete with scaled and labeled axes and can be hard-copied to paper.

TEK SPS BASIC data-logging capabilities let you turn tedious and repetitive measurements into automated procedures. Program control can eliminate human intervention, reduce errors, and give you time to concentrate on test results.

Better than seven-digit precision means much higher resolution than possible in conventional oscilloscope measurements. Special data structures retain both numeric and literal information associated with a given waveform. These waveform structures, as well as numeric arrays or portions of numeric arrays, can be operated on arithmetically as easily as can simple numeric variables.

Advanced Signal Processing
Waveforms can be integrated, differentiated, convolved, correlated, and fast Fourier transformed. Also, polar conversions can be performed.

Flexible I/O
Information can be read or written in ASCII or binary. ASCII may be used for display on a terminal or to store information for use by another software system. Binary can be used for storing large information blocks for later processing by TEK SPS BASIC. File may be structured either serially or by random access.

GPIB
With BASIC commands, you can control multiple IEEE Standard 488 interfaces at any level, from setting individual data lines to reading in entire arrays with a single command. The GPIB feature, which can be deleted from the BASIC system to save memory, is integrated with the Resident Monitor to make GPIB control commands more space economic. A high level GPIB driver is also available to facilitate programming for those not thoroughly familiar with GPIB.

There is also available a versatile GPIB software module for RSX11-M. This requires special quotation from SPS Marketing.

Extended Memory
Extended memory capability is offered in V02XM software. Computers with memory management and up to 128k words of memory can use extended memory to manipulate large data arrays.

Software Maintenance
Customers receive a periodic newsletter containing programming hints and responses to user questions. Reported system errors can usually be corrected by customer-applied "patches." These short code sequences are published in the newsletter with instructions for adding them to established systems. Specific problems encountered by customers which appear to be caused by software defect may be addressed by submitting a Software Performance Report (SPR) which will be responded to in writing. (Category B support.)

For additional information or a demonstration of the TEK SPS BASIC software family, call the Tektronix Sales Office in your area and ask for your Sales Engineer.

ORDERING INFORMATION
SOFTWARE PACKAGES

CP57000 TEK SPS BASIC (Monitor) . **$2,190**
CP57001 Signal Processing **$950**
CP57002 Graphics **$700**
CP57003 R7912 Transient Digitizer Driver **$950**
CP57004 Digitizing Oscilloscope (DPO) Driver **$500**
CP57005 DPO Envelope Command **$350**
CP57006 7912AD Programmable Digitizer Driver **$650**
CP57007 High Level Support **$350**
CP57008 Assembly Level Support **$1,000**
CP57009 GPIB High Level Driver **$500**
CP57010 7612D Special Commands **$300**
CP57500 Extended Memory (V02XM) TEK SPS Basic (Monitor) **$3,190**
CP575XX Extended Memory Software (V02XM) are priced the same as V02 modules above, except for CP57500.

The WP3201 is one of the many configurations for the minicomputer-based systems.

Systems

Tektronix Minicomputer-based systems offer combinations of Tektronix Waveform Digitizing instruments, flexible instrument controllers, and the most powerful waveform (array) processing BASIC software available on the market. These systems are tailored for medium and large scale experiments and for use in areas where medium or high power, dedicated systems are best suited to the task. System versatility and easy-to-use software allow for a wide variety of tasks to be performed at a multi-purpose test area. Large amounts of data storage and waveform analysis are manageable under the TEK SPS BASIC operating system which handles full arrays of data as easily as single-valued variables.

Instrument control and data communication are accomplished over the IEEE Standard 488 (GPIB) bus, allowing for easy expandability. Multiple instruments performing different functions may be added as needs expand or change. Control or data busses other than GPIB may be added by the user and controlled by TEK SPS BASIC software.

Mass storage includes either floppy or hard disk systems for operating system, non-resident commands, data files and user program storage. Hard copy capability may be added to these systems by ordering the Tektronix 4631 option.

AVAILABLE MINI-COMPUTER-BASED SYSTEMS

	7912AD	7612D
PDP-11/23/Floppy Disk*[1]	WP2252	WP3202
CP1164X/Hard Disk*[1]	WP2251	WP3201

[1] Later model minicomputers may be supplied.

Measurement requirements and technologies are changing rapidly in the dynamic fields of physics, optics, chemistry, biology, and electronics. Improved bandwidths, sensitivities, triggering circuits, and storage capabilities have done a great deal to increase the value of oscilloscopes as general-purpose measurement equipment in these fields. But in more and more applications scope measurements are being supplemented by computations to get the information in a form that is easy to interpret.

Some Applications

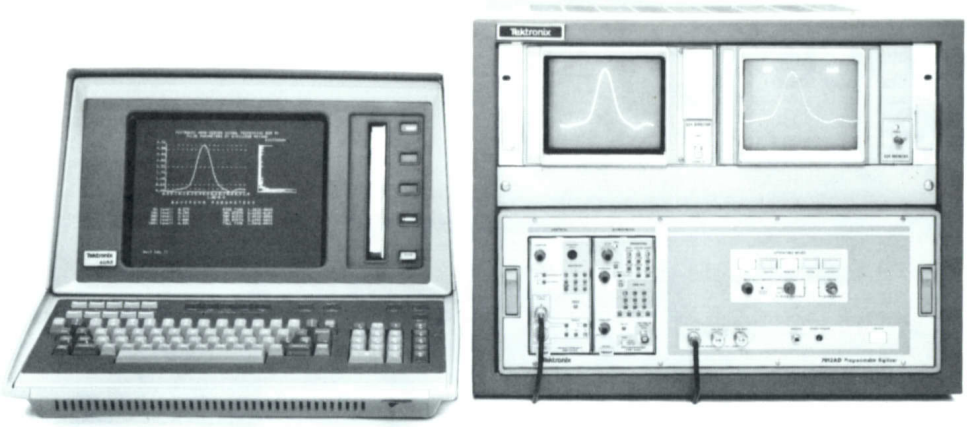
The development and manufacturing of today's increasingly complex electronic devices require extensive analysis of the signals these devices generate and transmit. For example, performance and calibration of high density cartridge disks can be characterized using Tektronix Signal Processing Systems — providing accurate, reliable results in seconds. Other components, such as semiconductors and optical fibers, have benefited from Tektronix Signal Processing System analysis.

Evaluating equipment designed to be used in hostile environments is a growing challenge for today's test and measurement technology. In the area of lightning effects, Tektronix Signal Processing Systems are used because they can capture randomly occurring events generated in such hostile environments. Other examples include shock and vibration testing, and electromagnetic pulse testing.

High performance instrumentation and waveform analysis have always been required in research and development for the discovery and quantification of new phenomena. With acquisition bandwidths up to 14 GHz, Tektronix Signal Processing Systems are ideally suited for such fields as laser-related research, fusion research, biochemistry, ballistics and ultrasonics.

Installation, Warranty and Service

Systems defined as "WP Systems" are installed at the customer's site free of charge. Warranty is as stated on page 41. Post warranty service is available on a normal charge basis, or system components may be sent to a service center for repair.



The WP2110 is one of three desktop computer-based systems.

Systems
Tektronix Desktop Computer-based Systems offer combinations of Tektronix Waveform Digitizing instruments and the 4052A Graphic Computing System. These systems are tailored especially for single user, small and medium scale experiments and for use in areas where medium power, dedicated, self contained systems are best suited to the task. Each system contains the flexibility to be easily moved between areas or to perform a variety of tasks at a multi-purpose test bench.

Instrument control and data communication are accomplished over the IEEE Standard 488 (GPIB) bus, allowing for easy expandability. Multiple instruments of the same type or GPIB-interfaced instruments performing different functions may be added as needs change. Data communication with external intelligence for additional flexibility is available via an RS-232C port. Hard-copy capability from the display may be added to these systems by ordering the Tektronix 4631 option. Raw and processed data and user programs may be stored using the integral magnetic tape, or the Tektronix 4907 flexible disk File Manager may be ordered to supplement the system.

Desktop Graphic Computer and Display
The Tektronix 4052A Graphic Computer has gained wide acceptance as a powerful data processing tool for system applications. For rapid calculations this desktop computer contains a fast processor with microcoded floating point.

The 4052A, with state-of-the-art graphics capability, can provide hard copies of any combination of text and high density graphics via an optional hardcopy unit. For peripheral support the 4052A uses the GPIB and RS-232C to interface with additional instruments as your needs require. And with memory expandable to 64k bytes, the 4052A can handle lengthy programs and large amounts of data.

AVAILABLE DESKTOP COMPUTER-BASED SYSTEMS

	7854	7912AD	7612D
4052A	WP1310	WP2110	WP3110

For complete information on SPS Systems and Digitizers described, contact your Sales Engineer for data sheets and descriptive literature through your nearby Tektronix Sales Office.

Desktop Computer Software
4052A software is an easy-to-learn enhanced form of BASIC which provides the simplicity desired by the beginner and the flexibility and power required by the experienced programmer. Device independent keywords make programming input and output operations easy. Fast matrix functions are also part of 4052A BASIC. Special ROM Packs provide 15 commonly used waveform processing functions—from the location of waveform maximums and minimums to Fast Fourier Transforms. And Tektronix supports the software of the 4052A with an extensive applications software library—including mathematics, statistics and graphics packages—which aids the user in solving measurement problems from modeling to final report generation.

For graphic display control, an entire set of commands allows graphic displays to be created on the 4052A. For example, one ROM Pack command provides the ability to display a complete array of data with a single statement.

Signal Processing ROM Pack #1 (4052, 4052A, 4054, and 4054A Only)
Adds seven new functions which can be applied to one dimensional data arrays; integration, differentiation (2 and 3 point), fast graphing, locating minimum and maximum, and crossing over a threshold. Functions operate 2-10 times faster than equivalent BASIC routines.
Order 4052R07 ..... $250

Signal Processing ROM Pack #2 (4052, 4052A, 4054, and 4054A Only)
Extends array handling capabilities by adding commands that perform Fast Fourier Transform (FFT), its inverse (IFT), convolution, correlation, windowing and related utility functions. Functions execute 7-20 times faster than BASIC routines.
Order 4052R08 ..... $495

Broad Support Completes the Package and Assures You of Continuing Value
From signal acquisition through final display ongoing support guarantees you the most value for your investment dollar. The many support programs available are yours as a part of your system purchase.

HANDSHAKE is a newsletter forum for users of Tektronix programmable instruments and systems. Published quarterly, *HANDSHAKE* has articles of interest concerning applications of measurement and analysis techniques.

SPS PROGRAMMING UPDATE is published periodically and sent to users of Tektronix Signal Processing Systems. It contains information to help maintain software and firmware system components. It also contains useful programming hints and software and firmware product information.

TM 5000 GPIB PROGRAMMABLE INSTRUMENTS

CONTENTS

DC 5010 Digital Counter 360
DC 5009 Digital Counter 361
DP 501 Digital Prescaler 363
DM 5010 Digital Multimeter 363
FG 5010 Function Generator 365
PS 5010 Power Supply 366
PS 5004 Power Supply 367
AA 5001 Distortion Analyzer 367
SG 5010 Programmable Oscillator 367
MI 5010 Programmable Multifunction Interface 369
MX 5010 Programmable Multifunction Interface 369
SI 5010 Programmable Scanner 372
TM 5003 Power Module Mainframe 402
TM 5006 Power Module Mainframe 402

Designed for Configurability; for Programming Ease; for Productivity.

Test and measurement setup has never been this friendly, has never been this fast. With Tek's line of TM 5000 programmables, you can continue to build on the concept of configurability. You can now link together customized, automated test packages with the same plug-in, pull-out ease as found in our TM 500 manual instrument line. You'll find these IEEE-488 compatible, fully programmable instruments are among the friendliest and fastest to integrate you can buy.

The 350 MHz DC 5010 Universal Counter/Timer is the state-of-the-art in high performance universal counter/timers. Its 1 ps time interval averaging resolution is unmatched for the industry.

For lower speeds, the 135 MHz DC 5009 Universal Counter/Timer is the industry's lowest cost, fully programmable counter/timer. It provides all of the functions of the higher-performance DC 5010 except rise/fall and null.

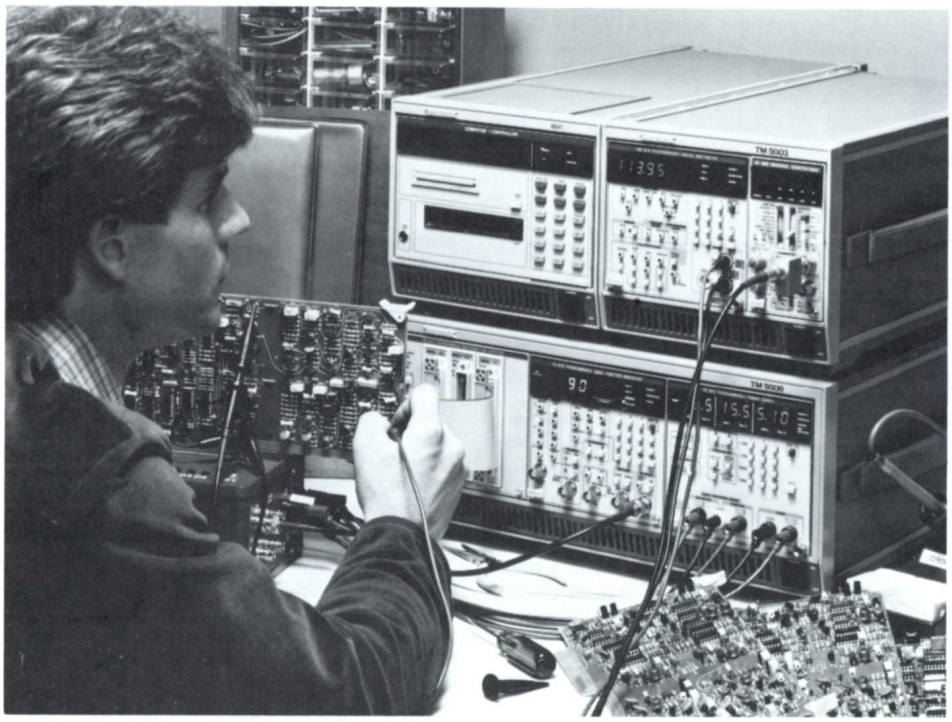
The DP 501 Digital Prescaler, although not GPIB compatible by itself, extends the frequency measurement capability of the DC 5010 and DC 5009 to 1.3 GHz under program control.

The DM 5010 Digital Multimeter measures dc and true RMS ac volts, ohms, and provides a diode test function. Internal math capabilities include averaging, nulling, offset, scaling, dB, and HI/LO/Pass sorting.

The FG 5010 Function Generator features variable symmetry throughout the full 20 MHz bandwidth of the instrument. Other important functions include counted burst, phase lock, and the ability to store and recall ten complete front panel setups.

The PS 5010 Power Supply, with its three separately programmable supplies, provides the most widely used voltages, all under complete program control, including current limit, source on/off, and extensive status reporting.

The PS 5004 Precision Power Supply provides the high-resolution voltages and currents necessary in the characterization of transistors, ICs, and other semiconductor and hybrid circuits. The actual values of the



output voltage, output current, and current limit may be read directly from the 4½-digit front panel display or are available over the GPIB.

The AA 5001 Programmable Distortion Analyzer and SG 5010 Programmable Oscillator are the world's first truly high-performance programmable audio test instruments. Together, they provide unequaled capability covering the full range of standard audio testing—THD, IMD, (SMPTE, DIN, CCIF difference tone), gain/loss, and signal-to-noise ratio. The AA 5001 is fully automatic in each of its operating modes—no tuning, no nulling, no level setting, no range changing—even with a remotely located signal source.

A complete range of system control and signal routing capabilities are available with the MI 5010 Multifunction Interface and MX 5010 Multifunction Interface Extender and the SI 5010 350 MHz Programmable Scanner. Function cards currently available for the MI 5010/MX 5010 Multifunction Interface System include: D/A converter, A/D converter, 32-channel digital I/O, 16-channel relay scanner, 10-channel low-level scanner, 16 k memory, and user-configurable development card.

Each TM 5000 instrument (with the exception of the completely automatic AA 5001) is fully programmable—all front panel functions are programmable over the GPIB. Each instrument (again with the exception of the AA 5001) has a front-panel ID button which can be programmed to cause the instrument to generate an SRQ when pushed, to allow operator intervention in an on-going test. Conversely, the SRQ generation capability can be programmed off to prevent inadvertent operator intervention. In addition, the entire front panel of each instrument can be locked out to further prevent operator interference with a test or instrument setup. When used with the execute-only version of the Tektronix 4041 System Controller, this means that you can place a completely operator-proof test system on the manufacturing floor; the operator can intervene only to the extent permitted by the test programmer.

In addition, Tektronix ***Standard Codes and Formats*** provides standardized data formats among all TM 5000 instruments, and among all other Tektronix GPIB instruments as well. Standardized instrument data formats open up the lines of bus communication and make your test and measurement system easy to set up and operate. Test and control functions are changed quickly and easily. Common error codes among instruments greatly simplify error-handling routines.

All of the TM 5000 instruments have internal diagnostics capability built right in. Each instrument performs an extensive diagnostic self-test on power-up or on command and, in case of a fault, displays and/or sends over the GPIB an error message indicating the nature of the fault. To further aid in troubleshooting and maintenance of the instruments, each has built-in signature analysis capability; each instruction manual gives a comprehensive list of signatures at nodes throughout the instrument.

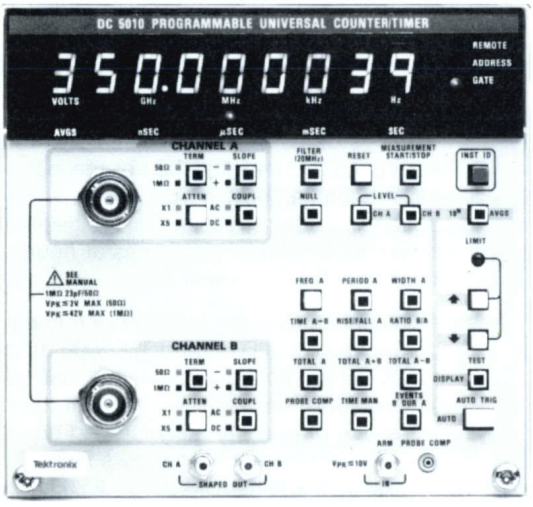
The compact, modular TM 5000 instruments operate in the TM 5003 and TM 5006 mainframes to form configurable automated test systems which occupy less than half the rack space of ordinary rackmounted equipment. The adjoining photo shows five TM 5000 instruments (DM 5010, DC 5009, MI 5010, FG 5010, and PS 5010) plus the powerful 4041 System Controller configured in a benchtop system approximately 15 inches high and 17 inches wide.

All of the current TM 5000 instruments are double-width, with the exception of the single-width DC 5009 and PS 5004. That is, each (except the DC 5009 and PS 5004) occupy two compartments of the three-compartment TM 5003 or the six-compartment TM 5006 mainframes.

Adherence to standard form and fit means that any TM 5000 product can be replaced in a system without the uncabling, unstacking, restacking, and recabling that is necessary with most instruments. Rebuilding the system for a different task takes seconds, not hours. And, if all instruments in your system need not be programmable, all 35-plus of Tek's TM 500 line of manual instruments are also compatible with TM 5000 mainframes.

All TM 5000 instruments are UL listed.

DC 5010



Programmable Universal Counter/Timer

GPIB IEEE-488

DC 5010

The DC 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

350 MHz Both A and B Channels

3.125 ns Single-Shot Resolution

9-Digit Display

1 ps Resolution, with Averaging

Measurement Functions Include:

- **Reciprocal Frequency Measurement**
- **Period**
- **Width**
- **Time A→B**
- **Events B During A**
- **Totalize A, A+B, A−B**
- **Ratio**
- **Rise/Fall**
- **Time Manual**
- **Arming**
- **Null**

Auto or Selected Averaging to 10^9 in All Modes

Duty-Cycle Independent Autotrigger

DVM Mode for Displaying Trigger Level Setting

Shaped A and B Channel Outputs

Hysteresis Compensation

Probe Compensation

Frequency measurements to 350 MHz (to 1.3 GHz with the Tektronix DP 501 Digital Prescaler), a wide range of time-interval measurement capabilities including rise and falltimes, hysteresis compensation, probe compensation, arming, and high resolution on low frequency signals (up to nine digits in one second or less), all combine to make the DC 5010 a true state-of-the-art universal counter/timer. Selected averaging of up to 10^9 events provides usable time-interval resolution to 1 ps on repetitive signals. The automatic averaging feature provides a compromise between measurement time and resolution, regardless of input signal frequency. The pseudo-random, phase modulated clock provides increased accuracy by eliminating the possibility of clock-synchronous errors in the time-interval averaging modes. Hysteresis compensation is automatic, further increasing the accuracy of time-interval measurements in the DC 5010. The Null feature permits the nulling of differences in cable lengths in time-intervalmeasurements to provide direct readout of the measurement of interest.

Autotrigger, at the push of a button or upon command over the GPIB, senses the maximum and minimum of the applied signal and sets trigger level to a point midway between the two, regardless of duty cycle. The values of the maximum and the minimum are available over the bus where they can be used by the controller to compute the p-p amplitude of the signal, providing the function of a high-frequency p-p DVM. The value of the trigger level is also available over the bus, and may also be displayed in the nine-digit DC 5010 display. The outputs of both channels' signal shaping circuits are available at the front panel to aid in the proper setting of trigger levels on complex waveforms. The arming input allows measurement of selected events within complex waveforms. The unique Probe Compensation feature permits quick and accurate compensation of attenuator-type probes to provide accurate measurements on signals beyond the amplitude range of the counter itself.

The frequency measurement of the DC 5010 can be extended to 1.3 GHz with the use of the companion DP 501 Digital Prescaler. TM 5000 rear interfacing capability permits the operation of the DP 501 to be controlled over the GPIB through the DC 5010.

A field-installable modification kit is available to upgrade a manual DC 510 Universal Counter/Timer (page 375) to a GPIB programmable DC 5010 Universal Counter/Timer.

CHARACTERISTICS

Display — Nine-digit LED display, automatic decimal point positioning, LED indicators for units, and measurement gate, and bus conditions. Overflow is indicated by a blinking display.

CHANNEL A AND B INPUT CHARACTERISTICS

Frequency Range

50 Ω Termination: 0 to 350 MHz dc coupled. 100 kHz to 350 MHz ac coupled.

1 MΩ Termination: 0 to 300 MHz dc coupled. 16 Hz to 300 MHz ac coupled.

Sensitivity

50 Ω Termination Dc: 25 mV RMS sinewave to 350 MHz. 70 mV p-p pulse.

1 MΩ Termination Ac: 25 mV RMS to 200 MHz, 42 mV RMS to 300 MHz.

Attenuation — Selectable 1X, 5X.

Impedance — 1 MΩ paralleled by 23 pF ±2 pF or 50 Ω.

Trigger Level Range — +2 V to −2 V with 4 mV resolution (X1). +10 V to −10 V with 20 mV resolution (X5).

Trigger Level Accuracy — ±2% of reading for a dc input V, ±40 mV x attenuator.

Dynamic Range — 4 V p-p x attenuation.

Autotrigger Frequency Range — 10 Hz to 350 MHz.

Independent Controls — Slope +/−, atten 1X/5X, Coupl ac/dc, Imped 1 MΩ/50 Ω.

Maximum Input Voltage — 1 MΩ input impedance.

1X: ±42 V (dc + peak ac) to 200 kHz; ±2 V (dc + peak ac) to 300 MHz.

5X: ±42 V (dc + peak ac) to 1 MHz; ±10 V (dc + peak ac) to 300 MHz.

In 50 Ω Input Impedance. Signals > ±2 V x attenuator will cause input protection circuitry to switch input to 1 MΩ.

Shaped Out — Shaped replica of signal being measured, aids proper triggering on complex waveforms (≥100 mV typically to 350 MHz into 50 Ω load).

Arming Input — Permits measurements of complex waveforms. A TTL high allows averaging of selected events within a measurement.

FREQUENCY A

Range — 36 µHz to 350 MHz.

Resolution —

$$\pm \text{LSD} \pm 1.4 \times \frac{\text{A Trigger Jitter Error}}{N} \times (\text{Frequency A})^2$$

Accuracy — Resolution ± (Time Base Error x Frequency A)

PERIOD A

Range — 3.125 ns to 7.6 hours.

Resolution —

$$\pm \text{LSD} \pm \frac{1.4 \times \text{A Trigger Jitter Error}}{N}$$

Accuracy — Resolution ± (Time Base Error) x Period A.

RATIO B/A

Range — 10^{-8} to 10^9 (Frequency range 36 µHz to 350 MHz).

Resolution —

$$\pm \text{LSD} \pm \frac{1.4 \times \text{B Trigger Jitter Error X Frequency B}}{N}$$

Accuracy — Same as Resolution.

TIME A→B

Range — 2.0 ns to 7.6 hours.

Resolution —

$$\pm \text{LSD} + \frac{1}{\sqrt{N}} \times (\pm \text{ CH A Trig Jitter Error} \pm \text{Ch B Trig Jitter Error})$$

Accuracy — Resolution ± (Time Base Error x Time A→B) + (B Trigger Slew Error) − (A Trigger Slew Error) ± (Channel Delay Mismatch*[1]).

Resolution — Best time A→B Avg resolution = ±1 ps.

Minimum Dead Time — 12.5 ns (stop to start).

Rep Rate — <70 MHz.

*[1] *Can be removed with "Null".*

Refer to Digital Counter Selection Guide on Page 374.

EVENTS B DURING A

Range — 10^{-8} to 10^{9}.

Maximum B Frequency — 350 MHz.

Maximum A Frequency — 80 MHz.

Minimum A Pulse Width — 4.0 ns (and 8.5 ns minimum time between pulses).

Resolution —

$$\pm\text{LSD} + \frac{\text{Frequency B}}{\sqrt{N}} \pm(\text{Trig Jitter Error CH A start edge} \pm \text{Trig Jitter Error CH A stop edge}).$$

Accuracy — Resolution + Freq B (Stop Slew Rate Error − Start Slew Rate Error) + Freq B x (5 ±2 ns).

WIDTH A

Range — 4 ns to 7.6 hours.

Resolution —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}}(\pm\text{Start Trig Jitter Error} \pm \text{Stop Trig Jitter Error})$$

Accuracy — Resolution ±(Time Base Error x Width A) + (Stop Slew Rate Error − Start Slew Rate Error) ±2 ns.

Minimum Dead Time Between Pulses — ≤8.5 ns.

Repetition Rate — 50 MHz maximum.

TIME MANUAL

Range — 0 to 3.125 x 10^{4} s (≈8 hours).

Resolution — ±LSD (100 ms).

Accuracy — ±Resolution ±(Time Base Error x Time).

TOTALIZE A

Range — 0 to 10^{9} counts.

Repetition Rate — 0 to 350 MHz.

TOTALIZE A+B

Range — 0 to 10^{9} counts (A+B ≤10^{9}).

Repetition Rate — 0 to 350 MHz.

TOTALIZE A−B

Range — −1 x 10^{8} to +1 x 10^{9} (either A >10^{12} or B >10^{12} will cause overflow).

Repetition Rate — 0 to 350 MHz.

RISE/FALL A

Range — 4 ns to 10^{4} s (50 Ω) 5 ns to 10^{4} s (1 MΩ).

Repetition Rate — Minimum time between rising (falling) edges is 12.5 ns (80 MHz).

Input Amplitude — (1.4 V to 8 V) x Attenuation (50 Ω), (0.7 V to 4 V) x Attenuation (1 MΩ).

Resolution —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}}(\pm\text{Start Trig Jitter Error} \pm \text{Stop Trig Jitter Error})$$

Accuracy — Resolution ±(Time Base Error x Risetime/Falltime) ±2 ns ±4 mV x Slew Rate A Error (near 10%) ±4 mV Slew Rate A Error (near 90%).

RESOLUTION AND ACCURACY DEFINITIONS

$$\text{Trigger Jitter Error (seconds RMS)} = \frac{\sqrt{(e_{n1})^2 + (e_{n2})^2\ \text{(Volts RMS)}}}{\text{Input Slew Rate at trigger point (V/s)}}$$

Where: e_{n1} = 140 μV RMS typical counter input noise for 1 MΩ filter on; 250 μV RMS typical for 1 MΩ, filter off and 340 μV RMS typical for 50 Ω.
e_{n2} = RMS Noise Voltage of input signal at trigger point measured with 350 MHz bandwidth.

Slew Rate Error (Seconds) = $\frac{\text{trigger level error (V)}^{*1}}{\text{Input slew rate at trigger point (V/s)}}$

*1Trigger level error =

All functions except Width and Events B During A	Positive Slope	Trigger accuracy times ATTN factor
	Negative Slope	(trigger accuracy ±10 mV) times ATTN factor
Width A ⎍	start edge	trigger accuracy times ATTN factor
	stop edge	(trigger accuracy + hyst) times ATTN factor
⎎	start edge	(trigger accuracy + hyst) times ATTN factor
	stop edge	trigger accuracy times ATTN factor
Events B During A	Same as Width, except each number is multiplied by (Frequency B)	

Note: Input hysteresis is typically 50 mV p-p x attenuation.
N=Number of events averaged.

The minimum number of averages is selected by the Averages button and the ↑ ↓ buttons in decade steps from 1 to 10^{9}. At Channel A repetition rates above ≈250 Hz the actual number of averages will be:

N = [Frequency A (Hz) x 4 ms] + Averages.
N = Averages setting (below 250 Hz).

This calculation typically leads to better than expected resolution in the displayed answer for small N with only minimal impact on measurement time. It does mean, however, that Arming must be used where only N = 1 is desired for signals ≥250 Hz.

In the Auto mode the counter measures with a fixed measurement time of about 300 ms (or the time for one event, whichever is greater).

N = Frequency A (Hz) x 0.3 s (N always ≥1).

Probe Comp display indicates 1 for over comp, 0 for under comp. Accuracy = (A x 0.300)%. A = Probe Attenuation times counter attenuator setting.

Time Base Error — The sum of all errors specified for the time based used.

STANDARD TIME BASE

Crystal Frequency — 10 MHz.
Temperature Stability — ±5 x 10^{-6}, 0°C to +50°C.
Aging Rate — ≤1 x 10^{-6}/year.
Setability — Adjustable to within ±5 x 10^{-8}.

HIGH STABILITY TIME BASE (OPTION 01)

Crystal Frequency — 10 MHz.
Temperature Stability — ±2 x 10^{-7} of final frequency in <10 minutes when cold started at 25°C.
Aging Rate — ≤1 x 10^{-8}/day at time of shipment, 4 x 10^{-8}/week after 30 days of continuous operation, 4 x 10^{-6}/year after 60 days of continuous operation.
Setability — Adjustable to within ±2 x 10^{-8}.

REAR INTERFACE

Inputs — Arming; reset; external time base (1, 5, or 10 MHz).
Outputs — 1 MHz clock.

OTHER CHARACTERISTICS

Power Consumption — 14.5 W (≈19.3 W for Option 01).
GPIB Data Output Rate — ≈10 readings/s maximum.
TM 5000 Power Module Compatibility — The DC 5010 is not compatible with TM 500 Series mainframes.

INCLUDED ACCESSORIES

Shaped output cable (012-0532-00); instruction manual; reference guide.

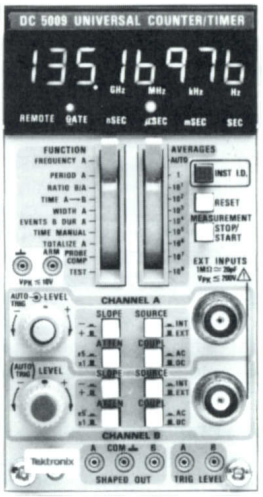
ORDERING INFORMATION

DC 5010 Programmable Universal Counter/Timer **$4,055**
Option 01 — High Stability Time Base ..... **+$305**
Field Option 01 Kit — For DC 510/5010
Order 040-0966-00 ..... **$250**
Utility Software **$150**
Refer to page 330 for description and ordering information.

RECOMMENDED PROBE

P6125 — 5X Passive Probe. Order 010-6125-01 ..... **$55**

DC 5009



Programmable Universal Counter Timer

GPIB IEEE-488

DC 5009

The DC 5009 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

135 MHz Both A and B Channels

10 ns Single-Shot Resolution

8-Digit Display

5 ps Resolution, with Averaging

Measurement Functions Include:

- **Reciprocal Frequency Measurement**
- **Period**
- **Width**
- **Time A→B**
- **Events B During A**
- **Totalize A→B**
- **Ratio**
- **Time Manual**
- **Arming**

Auto or Selected Averaging to 10^{8} in All Modes

Duty-Cycle Independent Autotrigger

Shaped A and B Channel Outputs

Probe Compensation

The DC 5009 single-width Universal Counter/Timer provides all of the measurement functions of the higher performance DC 5010 except rise/falltime, null, and totalize A ± B. This makes it the lowest cost fully programmable universal counter/timer available at the present time.

Refer to Digital Counter Selection Guide on Page 374.

The powerful reciprocal frequency measurement technique allows up to eight digits of resolution of low frequency signals in one second or less of measurement time. The DC 5009 has the same automatic averaging feature as the DC 5010; selected averaging of up to 10^8 events provides usable time-interval resolution of 5 ps.

Like the DC 5010, the frequency measurement capability of the DC 5009 can be extended to 1.3 GHz with the use of the DP 501 Digital Prescaler. The TM 5000 rear interfacing capability allows the operation of the DP 501 to be controlled over the GPIB through the DC 5009.

A field-installable modification kit is available to upgrade a manual DC 509 Universal Counter/Timer (page 375) to a GPIB programmable DC 5009 Universal Counter/Timer.

CHARACTERISTICS

Display — Eight-digit LED display, automatic decimal point positioning, LED indicators for units, and measurement gate. Overflow is indicated by a blinking display.

CHANNEL A AND B INPUT CHARACTERISTICS

Frequency Range — 0 to 135 MHz dc coupled, 10 Hz to 135 MHz ac coupled.

Sensitivity — 20 mV RMS sinewave to 100 MHz, 40 mV RMS sinewave to 135 MHz, 115 mV p-p at minimum. pulse width of 3 ns.

Attenuation — Selectable 1X, 5X.

Impedance — 1 MΩ paralleled by ≤30 pF.

Trigger Level Range — +3.200 V to −3.175 V with 25 mV resolution (X1). +16 V to −15.875 V with 125 mV resolution (X5).

Trigger Level Accuracy — ±45 mV ±40 μV/°C referenced to 25°C.

Auto Trigger Frequency Range — 20 Hz to 100 MHz (V_{in} ≥125 mV p-p).

Dynamic Range — V p-p ≤3 x Attenuation, tr ≤5 ns. V pk ≤3.2 x Attenuation.

Independent Controls — Slope +/−, Attenuation 1X/5X, Couple ac/dc, Source Internal/External.

Maximum Input Voltage
1X: 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p at 135 MHz.
5X: 200 V peak; 400 V p-p from dc to 5 MHz, derate to 25 V p-p at 135 MHz.

Shaped Out — Shaped replica of signal being measured, aids proper triggering on complex waveforms. Amplitude 0 to ≥+0.3 V from 50 Ω.

Trigger Level Out — A dc level corresponding to the actual trigger level. Accuracy within ±30 mV of internal trigger level.

Arming Input — Permits measurements of complex waveforms. A TTL high allows averaging of selected events within a measurement.

FREQUENCY A

Range — 100 μHz to 135 MHz.

Resolution —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{Trigger Jitter Error}}{N} \times (\text{Frequency A})^2$$

Accuracy —
Resolution ±(Time Base Error x Frequency A)

PERIOD A

Range — 7.40 ns to 3.05 hours.

Resolution —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{A Trigger Jitter Error}}{N}$$

Accuracy — Resolution ±(Time Base Error x Period A).

RATIO B/A

Range — 10^{-7} to 10^8 (Frequency Range: CH A to 135 MHz; CH B to 125 MHz.)

Resolution —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{B Trigger Jitter Error x Frequency B}}{N}$$

Accuracy — Same as Resolution.

TIME A → B

Range — 15 ns to 3.05 hours.

Minimum Dead Time — 15 ns (stop to start).

Resolution —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}} \times (\pm\text{CH A Trigger Jitter Error} \pm \text{CH B Trigger Jitter Error})$$

Accuracy — Resolution ±(Time Base Error x Time A → B) + (CH B Slew Rate Error − CH A Slew Rate Error) ±Channel Delay Mismatch.

Channel Delay Mismatch — <2 ns between front panel inputs and <3 ns between rear interface inputs.

EVENTS B DURING A

Range — 10^{-7} to 10^8.

Maximum B Frequency — 125 MHz.

Minimum A Pulse Width — 15 ns.

Minimum Time Between A Pulses — 15 ns.

Minimum Time Between "A" Start Edge and First "B" Event — 15 ns.

Resolution —

$$\pm\text{LSD} + \frac{\text{Frequency B}}{\sqrt{N}} (\pm\text{Trigger Jitter Error CH A start edge} \pm \text{Trigger Jitter Error CH A stop edge.})$$

Accuracy — Resolution + Frequency B (Stop Slew Rate Error — Start Slew Rate Error).

WIDTH A

Range — 15 ns to 3.05 hours.

Minimum Dead Time Between Pulses — 15 ns.

Resolution —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}} (\pm\text{Start Error} \pm \text{Stop Trigger Jitter Error})$$

Accuracy — Resolution ±(Time Base Error x Width) + (Stop Slew Rate Error — Start Slew Rate Error) ±5 ns.

TIME MANUAL

Range — 0 to 3.05 hours. May be extended with GPIB.

Resolution — ±LSD (100 ms).

Accuracy — ±Resolution ±(Time Base Error x Time).

TOTALIZE A

Range — 0 to 1.09 x 10^{12} counts. May be extended with GPIB.

Repetition Rate — 0 to 135 MHz.

PROBE COMPENSATION

Display — 1 or 0 for each channel.

Accuracy —

$$\frac{\text{Probe Atten X 50 mV X 100 (\%)}}{V_{in} \text{ at Probe}}$$

(2.5% nominal for X5 probe with 10 V p-p at the probe).

RESOLUTION AND ACCURACY DEFINITIONS

Trigger Jitter Error (Seconds RMS) —

$$\frac{\sqrt{(e_{n1})^2 + (e_{n2})^2 \text{ (Volts RMS)}}}{\text{Input Slew Rate at trigger point (V/s)}}$$

Where: e_{n1} = 120 μV RMS typical counter input noise
e_{n2} = RMS Noise Voltage of input signal at trigger point measured with 150 MHz bandwidth.

Slew Rate Error (seconds) —

$$\frac{\text{Input Hysteresis/2}}{\text{Input Slew Rate at trigger point (V/s)}}$$

Note: Input hystersis is typically 20 mV p-p.

N = Number of Events Averaged

The minimum number of averages is selected by the Averages control in decade steps from 1 to 10^8. At CH A repetition rates above ≈250 Hz, the number of events averaged will be:

N = [Frequency A (Hz) x 4 ms] +Averages.

N = Averages setting below 250 Hz.

In the Auto mode, the counter measures with a fixed measurement time of about 300 ms.

N (Auto) ≈ Frequency A (Hz) x 0.3 seconds.

N is always ≥1.

Time Base Error — The sum of all errors specified for the time base used.

STANDARD TIME BASE

Crystal Frequency — 10 MHz.

Temp Stability — ±5 x 10^{-6}, 0°C to +50°C.

Aging Rate = 1 x 10^{-6} per year.

Setability — Adjustable to within ±1 x 10^{-7} or better.

HIGH STABILITY TIME BASE (OPTION 01)

Crystal Frequency — 10 MHz.

Stability — ±2 x 10^{-7} after warm-up, 0°C to +50°C.

Warm-up Time — Within 2 x 10^{-7} of final frequency in <10 minutes when cold-started at 25°C.

Aging Rate — 1 x 10^{-8}/day at time of shipment, 4 x 10^{-8}/week after 30 days of continuous operation, 1 x 10^{-6}/year after 60 days of continuous operation.

Setability — Adjustable to within 2 x 10^{-8}.

REAR INTERFACE

Inputs — Channel A and B input to 50 MHz (50 Ω impedance, maximum input 3.6 V peak); arming; reset; external time base (1, 5, or 10 MHz), prescale.

Outputs — Channel A and B shaped outputs; Channel A and B trigger level outputs; 10 MHz clock; gate out.

OTHER CHARACTERISTICS

Power Consumption — ≈12 W (≈15 W with Option 01).

GPIB Data Output Rate — ≈10 readings/s maximum.

INCLUDED ACCESSORIES

Tip jack to BNC adaptor cable (175-3765-01); instruction manual; reference guide.

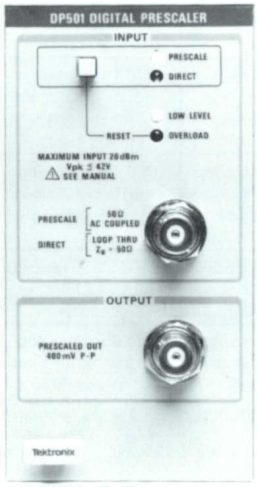
ORDERING INFORMATION

DC 5009 Programmable Universal Counter Timer **$2,285**
Option 01 — High Stability Time Base ..... **+$305**
Field Option 01 Kit — For DC 509
Order 040-0966-00 ..... **$250**
Utility Software **$150**
Refer to page 330 for description and ordering information.

RECOMMENDED PROBE

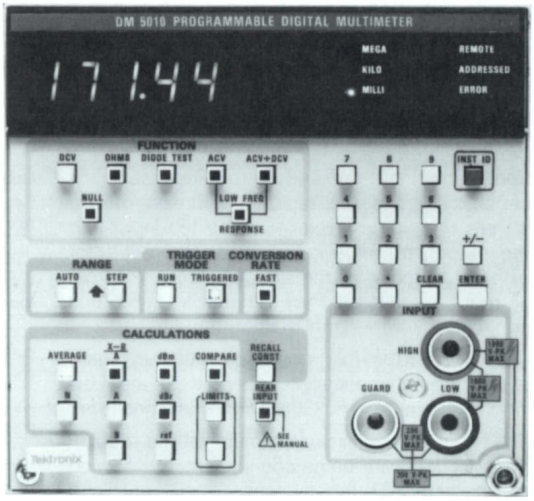
P6125 — 5X Passive Probe
Order 010-6125-01 ..... **$55**

DP 501



Digital Prescaler

DM 5010



Programmable Digital Multimeter

NEW DP 501

Extends Frequency Measurement Capability to 1.3 GHz

Compatible with Most TM 5000 and TM 500 Counters

AGC

Low Level Indicator

The DP 501 Digital Prescaler adds 1.3 GHz frequency counting capability to the Tektronix DC 509/5009, DC 510/5010, and DC 503A Universal Counter/Timers while still allowing full use of all counter/timer functions. There is no need to change input connections as with counters which use the conventional C-Channel input.

The DP 501 is placed in the signal line between the signal source and the counter's input connector such that the signal to be measured passes through the DP 501. Two operating modes are available, Prescale and Direct. In the Prescale mode, the DP 501 divides the input signal frequency by 16 and the associated counter's display to be multiplied by 16 (so that the counter will display the correct frequency). In the Direct mode the signal is simply looped through the DP 501 and applied directly to the counter's input; the counter's display is not affected. This loop-through capability eliminates the need for external switching of the input signal when changing from high frequency measurements to low frequency or time-interval measurements.

The prescaling function can be activated in either of two ways: manually, with a front-panel pushbutton; or, by the "Prescale On" command to the counter when using a GPIB programmable DC 5009 or DC 5010.

Input sensitivity in the Prescale mode is 20 mV RMS to 1 GHz and 30 mV RMS to 1.3 GHz. A Low-Level indicator alerts the user if the input signal amplitude is too low for error-free counting. An automatic gain control circuit provides optimum immunity to signal noise in the Prescale mode.

The DP 501 and the DC 509/5009 or DC 510/5010 Universal Counter/Timers can be used with the Tektronix 7L14 Spectrum Analyzer (see page 218) and TR 502 Tracking Generator (see page 223) to provide counter accuracy measurements of swept-frequency signals from 100 kHz to 1.3 GHz.

The DP 501 operates in a single compartment of either a TM 500 or TM 5000 mainframe.

CHARACTERISTICS

Prescale Mode
Input: Frequency range is ≤100 MHz to ≥1.3 GHz.
Sensitivity: 100 MHz to 1 GHz is ≤20 mV RMS (−21 dBm).
1 GHz to 1.3 GHz is ≤30 mV RMS (−17 dBm).
Impedance: 50 Ω ac coupled; vswr ≤2.2:1.
Output: Amplitude into 50 Ω is ≥200 mV. Unterminated is 2X terminated value.

Direct Mode
Input: Connected directly to output.
Frequency Range: 0 to >350 MHz.
Impedance: Loop through characteristic impedance is 50 Ω; nonterminated capacitance ≈20 pF (no connection to output).
Output: Connected directly to input. <1 dB insertion loss up to 350 MHz. Powers up in direct mode.

Overload Protection
Prescale: Input disconnects when input signal exceeds +20 dBm ±5 dBm for a period of ≈0.5 s or more.

Damage Level
Prescale: Input may be damaged if signal level exceeds +25 dBm.
Direct: 42 V peak maximum. Maximum current is 250 mA.

Input Attenuation
Automatic: Up to 40 dB range.

Low Level Indicator — Lights when input signal is below that required for error-free counting.

Tracking Generator Compatibility — Outputs will drive two standard TTL loads. Inputs represent two standard TTL loads. Requires arming input to associated counter.

Included Accessory — Instruction manual.

Order DP 501 Digital Prescaler **$500**

GPIB IEEE-488 DM 5010

The DM 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

4 1/2 Digit, Autoranging

Dc Volts, Ohms, True RMS (ac or ac+dc)

Diode Test

Comprehensive Math Functions:

- **dB Calculations**
- **Averaging**
- **Offset**
- **Scaling**
- **Hi/Lo/Pass**

The DM 5010 Programmable Digital Multimeter measures dc voltage, resistance, true RMS ac voltage, and true RMS ac+dc voltage. The internal math capability of the DM 5010 provides most of the calculations normally required for reducing raw measurements to decision-supporting information without controller assistance. These calculations include averaging (up to 19,999 measurements), offset and scaling, conversion to dBm or reference dB, and Hi/Lo/Pass comparisons. User-selectable constants required for calculations may be supplied either through the front-panel keypad or via the GPIB.

The internal math capability of the DM 5010 permits such specialized measurements as: ac or dc current measurements, through the use of an external shunt resistor and a scaling factor equal to the ohmic value of the resistor; comparison against a percent tolerance (as opposed to an absolute value tolerance) through the combined use of the scaling and Hi/Lo/Pass functions.

Refer to DMM Selection Guide on Page 382.

The low voltage (0.2 volt) ohms function allows in-circuit resistance measurements without turning on parallel diode and transistor junctions. A Diode Test function is provided for forward and reverse testing of diode and transistor junctions.

The versatile TM 5000 rear interfacing capability allows signals to be applied to the DM 5010 via the rear interface connector as well as via the front panel input jacks. This front-rear selection capability allows the rapid comparison of two signals or voltage levels, such as the input and the output of a device, without the need for external switching of the signal. Selection of front or rear signal input may be made under bus control or by front-panel pushbutton.

The DM 5010 is fully guarded, with the Guard connector automatically connected to the Low input when there is no Guard signal lead inserted.

The Null function eliminates much of the requirement for four-wire ohms connections by allowing the operator, or the system, to null out lead resistance in resistance measurements. The Null function also allows the difference between two measurements to be displayed, either directly or as a dB difference.

A special Low Frequency Response function permits stable readouts of low frequency ac voltages.

Range selection is either automatic or manually incremented. Measurements and calculations may be triggered by internal circuitry, a front-panel pushbutton, a rear interface signal, or a GPIB command.

Calibration of the DM 5010 is greatly simplified through the use of internal microprocessor-computed nonvolatile calibration constants.

CHARACTERISTICS

DC VOLTS

Ranges — 200 mV, 2 V, 20 V, 200 V, 1000 V.

Accuracy[*1]

+18°C to +28°C	Normal Conversion Rate	Fast Conversion Rate
200 mV	±[0.015% of reading +0.01% of full scale (2 counts)]	±[0.05% of reading +0.05% of full scale (1 count)]
2 V through 200 V	±[0.015% of reading +0.005% of full scale (1 count)]	±[0.05% of reading +0.05% of full scale (1 count)]
1000 V	±[0.020% of reading +0.010% of full scale (2 counts)]	±[0.05% of reading +0.1% of full scale (2 counts)]
0°C to 18°C, +28°C to +50°C	**Normal Conversion Rate**	**Fast Conversion Rate**
200 mV	±[0.06% of reading +0.035% of full scale (7 counts)]	±[0.1% of reading +0.1% of full scale (2 counts)]
2 V through 200 V	±[0.06% of reading +0.03% of full scale (6 counts)]	±[0.1% of reading +0.1% of full scale (2 counts)]
1000 V	±[0.065% of reading +0.035% of full scale (7 counts)]	±[0.1% of reading +0.15% of full scale (3 counts)]

*[*1] Valid for six months or 1000 operating hours, whichever occurs first.*

Common-Mode Rejection Ratio (With 1 kΩ Imbalance) — Unguarded: ⩾130 dB at dc. ⩾80 dB at 50 Hz to 60 Hz. Guarded: ⩾140 dB at dc. ⩾100 dB at 50 Hz to 60 Hz.

Normal-Mode Rejection Ratio — ⩾40 dB at 50 Hz or 60 Hz ±0.2 Hz.

Maximum Resolution — 10 μV.

Step Response Time (To Rated Accuracy)
Run Mode: Normal conversion rate is ⩽0.53 s.
Fast conversion rate is ⩽0.08 s.
Triggered Mode: Normal conversion rate is ⩽0.33 s.
Fast conversion rate is ⩽0.06 s.

Input Resistance — 200 mV to 20 V Range: >10[9] Ω.
200 V to 1000 V Range: 10 MΩ ±0.25%.

Maximum Input Voltage — 1000 V peak.

TRUE RMS AC VOLTS (ACV AND AC+DC)

Input Signal — Must be between 5% and 100% of full scale.

Ranges — 200 mV, 2 V, 20 V, 200 V, 700 V.

Accuracy[*1]

+18°C to +28°C	Normal and Fast Conversion		
Voltage Ranges	**20 Hz to 100 Hz**	**100 Hz to 20 kHz**	**20 kHz to 100 kHz**
200 mV through 200 V	±(0.8% of rdg +0.2% of full scale)	±(0.2% of rdg +0.2% of full scale)	±(1.0% of rdg +0.5% of full scale)
700 V (15 kHz max)	±(0.8% of rdg +0.6% of full scale)	±(0.2% of rdg +0.6% of full scale)	
0°C to +18°C, +28°C to +50°C	**Normal and Fast Conversion**		
200 mV through 200 V	±(1.25% of rdg +0.35% of full scale)	±(0.65% of rdg +0.3% of full scale)	±(1.45% of rdg +0.65% of full scale)
700 V (15 kHz max)	±(1.25% of rdg +0.95% of full scale)	±(0.65% of rdg +0.95% of full scale)	

Ac Volts + Dc Volts Only	
+18°C to +28°C	**Normal and Fast Conversion Rate; 10Hz to 20 Hz**
200 mV through 200 V	±(0.8% of rdg +0.3% of full scale)
700 V	±(0.8% of rdg +0.9% of full scale)
0°C to +18°C, +28°C to +50°C	**Normal and Fast Conversion Rate; 10Hz to 20 Hz**
200 mV through 200 V	±(1.25% of rdg + 0.45% of full scale)
700 V	±(1.25% of rdg + 1.25% of full scale)

*[*1] Valid for a period of six months or 1000 hours, whichever occurs first.*

Common-Mode Rejection Ratio — Unguarded: Typically ⩾80 dB from dc to 60 Hz. Guarded: Typically ⩾100 dB from dc to 60 Hz.

Maximum Resolution — 10 μV.

Response Time — <1.2 s (except for Low Frequency Response mode).

Input Impedance — 2 MΩ ±0.1% paralleled by <150 pF.

Maximum Input Voltage — 1000 V peak ac, 500 V dc.

Crest Factor — 4 (subject to maximum peak input voltage).

DIODE TEST

Operation — A 1 mA current is generated and the resultant voltage is measured on the 2 V dc range. This produces a voltage sufficient to turn on diode and transistor junctions.

RESISTANCE

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ.

Accuracy[*1]

+18°C to +28°C		
Resistance Range	**Normal Conversion Rate**	**Fast Conversion Rate**
200 Ω	±[0.015% of reading +0.015% of full scale (3 counts)] (using null)[*2]	±[0.05% of reading +0.05% of full scale (1 count)] (using null)[*2]
2 kΩ to 200 kΩ	±[0.015% of reading +0.01% of full scale (2 counts)] (using null on 2 kΩ only)[*2]	±[0.05% of reading +0.05% of full scale (1 count)]
2 MΩ	±[0.10% of reading +0.01% of full scale (2 counts)]	±[0.10% of reading +0.05% of full scale (1 count)]
20 MΩ	±[0.15% of reading +0.005% of full scale (1 count)]	±[1.0% of reading +0.05% of full scale (1 count)]

Accuracy[*1]

0°C to +18°C, +28°C to +50°C		
Resistance Range	**Normal Conversion Rate**	**Fast Conversion Rate**
200 Ω	±[0.06% of reading +0.06% of full scale (12 counts)] (using null)[*2]	±[0.1% of reading +0.1% of full scale (2 counts)] (using null)[*2]
2 kΩ to 200 kΩ	±[0.06% of reading +0.035% of full scale (7 counts)] (using null on 2 kΩ only)[*2]	±[0.1% of reading +0.1% of full scale (2 counts)]
2 MΩ	±[0.54% of reading +0.035 of full scale (7 counts)]	±[0.55% of reading +0.1% of full scale (2 counts)]
20 MΩ	±[0.9% of reading +0.01% of full scale (2 counts)]	±[1.6% of reading +0.05% of full scale (1 count)]

*[*1] Valid for a period of six months or 1000 hours, whichever occurs first.*
*[*2] When the null function is not used add ±0.2 Ω to all readings.*

Maximum Resolution — 10 mΩ.

Step Response Time (To Rated Accuracy)
Run Mode: Normal conversion rate is ⩽1.24 s.
Fast conversion rate is ⩽0.33 s.
Triggered Mode: Normal conversion rate is ⩽0.73 s.
Fast conversion rate is ⩽0.19 s.

Maximum Input Volts — 400 V peak.

Maximum Open Circuit Voltage Developed — <5 V.

OTHER CHARACTERISTICS

Overrange Indication — For Ohms and Diode Test, "OC" is displayed; for ACV, DCV, ACV+DCV, the display blinks.

Measurement Rate — ACV, DCV, ACV+DCV, Diode Test: 3/s at 4.5 digits; 26/s at 3.5 digits. Ohms: 1.6/s at 4.5 digits; 7.1/s at 3.5 digits.

Power Consumption — ≈20 VA.

IEEE-488 1978 Interface Function Subsets Implemented — SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0.

INCLUDED ACCESSORIES

One set test leads (003-0120-00); instruction manual.

Order DM 5010 Programmable Digital Multimeter **$2,075**

Utility Software **$150**

Refer to page 330 for description and ordering information.

OPTIONAL ACCESSORIES

Test Lead — Black, 4 ft. Order 012-0425-00 ..... **$12**

Test Lead — Red, 4 ft. Order 012-0426-00 ..... **$17.50**

Test Lead — Black, 4 ft. Order 012-0426-01 ..... **$17.50**

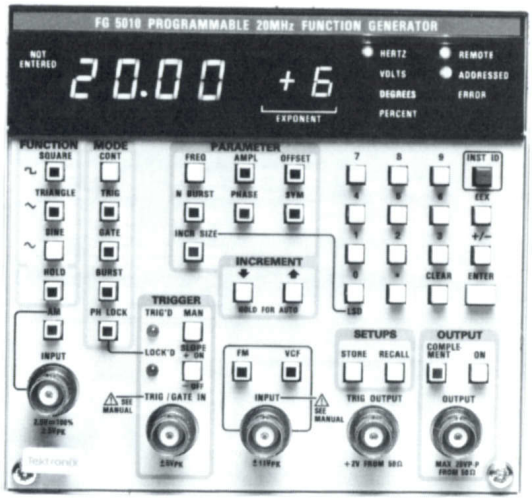
Test Lead Set — Includes 012-0425-00, 012-0426-00, and 013-0107-03. Order 012-0427-00 ..... **$29**

High Voltage Probe — To 40 kV (complete information page 384). Order 010-0277-00 ..... **$135**

P6420 RF Probe — 2 m cable included (complete information page 443). Order 010-6420-03 ..... **$138**

Female BNC to Dual Banana Adaptor — Order 103-0090-00 ..... **$7.50**

FG 5010



Programmable 20 MHz Function Generator

GPIB IEEE-488

FG 5010

The FG 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

0.002 Hz to 20 MHz

Up to 20 V p-p from 50 Ohms

Sine, Square, Triangle, Pulse, and Ramp Waveforms

10 ns Rise/Fall

10% to 90% Variable Symmetry in 1% Steps

Trigger, Gate, Counted Burst

Phase Lock, with Autoscan

AM, FM, VCF

Waveform Complement

The FG 5010 Programmable 20 MHz Function Generator is a highly versatile GPIB programmable instrument and also extremely easy to operate in the manual mode as well. All functions are addressable via the lighted front-panel pushbuttons with nomenclature and functionality clearly designated. The ability to store ten complete front panel setups and recall them with only two keystrokes or by a single command over the GPIB reduces GPIB programming time and enhances stand-alone bench applications.

The FG 5010 provides the conventional sine, square, triangle, pulse, and ramp waveforms. Variable symmetry, which is usable throughout the entire frequency range, extends pulse and ramp capabilities beyond those of conventional generators. The FG 5010 also provides trigger, gate, counted burst, phase lock, AM, FM, and VCF modes. Variable phase enhances the trigger, gate, burst, and phase lock modes.

The wide frequency range assures its usefulness in radio and other communication-oriented applications as well as in low frequency applications, such as biological, geophysical, and mechanical simulations.

The FG 5010 maintains frequency accuracy within 0.1% over its full 0.002 Hz to 20 MHz frequency range. Automatic phase lock to an external signal is possible from 20 Hz to 20 MHz. Waveform complement and +/− trigger slope allow interfacing to circuits with the proper waveform phase, especially important in pulse and digital applications. Waveform hold can freeze the output voltage of any 200 Hz or less waveform at its instantaneous value. With the output amplitude set to zero volts, the dc offset can be programmed to provide a dc voltage source of 0 to ±7.5 volts in 10 mV steps.

CHARACTERISTICS

Waveform — Sine, Square and Triangle with variable Symmetry providing Pulses and Ramps.

Symmetry — 10% to 90%, 1% steps, ±2% accuracy. Range above 4 MHz is limited by 25 ns minimum triangle transition time (decreases to 50% at 20 MHz).

Frequency — Range: 0.002 Hz to 20 MHz. Accuracy: Continuous mode, ±0.1%. Trigger, Gate, Burst Modes: Frequency ≤200 Hz, ±0.1%; frequency >200 Hz, ±5.0%. Resolution: Continuous mode, 4 digits, Trigger, Gate, Burst modes. Frequency ≤200 Hz, 4 digits. Frequency >200 Hz, 3 digits.

Amplitude — Range: 20 mV to 20 V p-p from 50 Ω into open circuit.

Accuracies[*1]

Frequency	Sine	Square	Triangle
0.002 Hz to 1 kHz	±3%	±2%	±2%
1 kHz to 100 kHz	—	—	±3.5%
1 kHz to 1 MHz	±3.5%	±3.5%	—
100 kHz to 1 MHz	—	—	±4%
1 MHz to 5 MHz	±5%	—	+4%, −5%
1 MHz to 10 MHz	—	±5%	—
5 MHz to 20 MHz	±5%, −10%	—	+4%, −20%
10 MHz to 20 MHz	—	±10%	—

*[*1] Measured at +25°C ±10°C into 50 Ω load at 50% symmetry. Resolution: 20 mV from 2.02 V to 20.00 V p-p, 2 mV from 202 mV to 2.000 V p-p, 0.2 mV from 20.0 mV to 200.0 mV p-p.*

Offset — Range: −7.5 V to +7.5 V from 50 Ω into an open circuit. Maximum peak signal plus offset cannot exceed ±15 V open circuit, Accuracy: All waveforms except squarewave >2 MHz ≤ ±(1% of the selected offset, + 2% of the signal p-p amplitude, +20 mV). Squarewave >2 MHz < ±(1% of the selected value +5% of the signal p-p amplitude +20 mV). Resolution: 10 mV open circuit, 5 mV into 50 Ω load. 0 V is also provided.

Output Impedance — 50 Ω.

Sinewave Distortion — 20 Hz to 19.99 kHz, ≤0.5%; 20.0 kHz to 99.99 kHz, ≤1.0%; 100 kHz to 20.0 MHz, harmonics >30 dB down from 100 kHz to 20 MHz. Valid from +15°C to +35°C into 50 Ω load with 0 V offset, continuous mode, 50% symmetry, and AM, FM, VCF, and Complement off.

Squarewave Response — Risetime and falltime are ≤10 ns. Aberrations are ≤5% p-p +20 mV.

Typical Triangle Linearity (10% to 90%) — 0.002 Hz to 200 Hz, ≤1%; 200 Hz to 100 kHz, ≤1%; 100 kHz to 2 MHz, ≤2%; 2 to 20 MHz, ≤10%.

Trigger Output — 0 V ±100 mV to ≥+2 V from 50 Ω source impedance into an open circuit.

TRIG, GATE, BURST, AND PH LOCK INPUT

Input Impedance — 1 MΩ or 50 Ω, internally selectable.

Trigger Threshold — 0 V or + 0.5 V, internally selectable.

Amplitude Sensitivity — ≤250 mV p-p.

Slope — Plus or minus, plus only in Ph Lock.

Minimum Pulse Width — 25 ns.

Maximum Frequency — 20 MHz.

Maximum Input Amplitude — ±5 V peak into 50 Ω, ±20 V peak into 1 MΩ.

Burst Range — 1 to 9999 cycles.

Phase Lock Range — Automatic capture from 20 Hz to 20 MHz.

Phase Lock Time — Typically 8 ms to 88 s, depending on final frequency and start frequency.

AM INPUT

Input Impedance — 10 kΩ (±5% when AM is selected).

Sensitivity — 5 V p-p produces ≥100% modulation.

Distortion — <2% at 70% modulation and ≤2 MHz; <4% at 70% modulation and >20 MHz.

Bandwidth — Dc to ≥100 kHz.

Maximum Input Amplitude — ±20 V pk.

FM INPUT

Input Impedance — 10 kΩ.

Sensitivity — 0 to ±1V modulates to ≥±1% deviation from center frequency.

Distortion — ≤2%.

Bandwidth — Dc to ≥100 kHz.

Maximum Input — ±20 V peak.

VCF INPUT

Input Impedance — 10 kΩ ±5%.

Sensitivity — 0 to 10.0 V produces a ≥1000:1 frequency change, positive going voltage increases frequency.

Slew Rate — ≥0.063 V/μs.

Bandwidth — Dc to ≥100 kHz.

Maximum Input — ±20 V peak.

OUTPUT HOLD MODE

Range — 0.002 Hz to 200 Hz. (Output holds at instantaneous value).

PHASE (TRIG, GATE, AND BURST MODES)

Range — ≤90° to 1 MHz, decreasing to ≤80° at 20 MHz.

Accuracy —

$\pm 3°$ to 500 kHz; $\pm [7° + (\frac{\text{freq}}{20\text{ MHz}} \times 28\% \times |\Phi|)°]$ for freq >500 kHz

At 25 ±10°C VCF off, output in Normal and symmetry at 50%.

Resolution — 1°.

PHASE (PH LOCK MODE)

At 25 ±10°C.

Range — ≤90°, 20 Hz to ≤10 MHz; ≤45° to ≥10 MHz (Complementing the output extends effective 0 range to ±180°).

Accuracy — ± (2° +5% of selected value).

Resolution — 1°.

IEEE-488 1978 Interface Function Subsets Implemented — SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.

OTHER CHARACTERISTICS

Power Consumption — 60 W.

INCLUDED ACCESSORIES

Instruction manual; reference guide.

ORDERING INFORMATION

FG 5010 20 MHz Function Generator **$4,300**

OPTIONAL ACCESSORIES

Rear Interface Signal Cable Kit — Order 020-0701-00 . **$35**

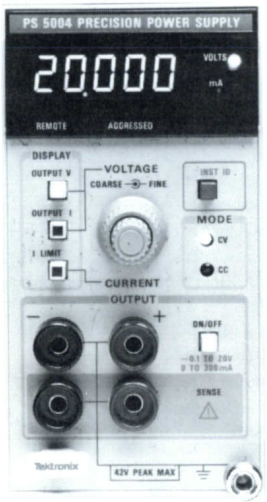
Service Kit — Order 067-1041-00 ..... **$250**

Utility Software **$150**

Refer to page 330 for description and ordering information.

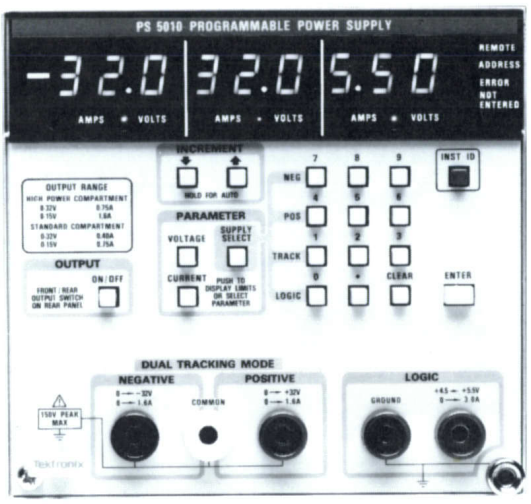
NEW

PS 5004



Programmable Precision Power Supply

PS 5010



Programmable Triple Power Supply

GPIB IEEE-488 NEW PS 5004

The PS 5004 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

0 to 20 V Floating Output

0.01% Accuracy

500 μV Resolution

Constant Voltage or Constant Current with Autocrossover

Voltage and/or Current Monitoring Display

The single-width PS 5004 Precision Power Supply provides the high-resolution voltages and currents necessary in the characterization of transistor, IC, and other semiconductor and hybrid circuits and in the operation of high-performance strain gages and other transducer systems. Its entire 0 to 20 V output is covered with a coarse and fine adjustment to provide rapid setability and ±500 μV resolution without the necessity of changing ranges. Setability resolution over the GPIB is also ±500 μV. The supply output is available at the rear interface as well as from the front panel terminals. Overall accuracy is ±0.01% ±2mV.

The PS 5004 operates in either a constant voltage or constant current mode with autocrossover between the two. Front panel annuciators indicate the mode at all times. The operating mode is also reported over the bus and the PS 5004 may be programmed to assert SRQ whenever operating conditions cause it to change from one mode to the other.

The 4½ digit display shows actual output voltage, selected current limit, or actual output current. The actual output voltage is shown even when the PS 5004 is operating in the current-limited or unregulated mode. Display resolution is 1 mV or 0.1 mA.

The buffered high-impedance sense terminals allow proper regulation of the supply with up to 3 Ω of resistance in either of the sense leads.

CHARACTERISTICS

CONSTANT VOLTAGE MODE

Range — 0 V to 20 V in 0.5 mV steps.

Overall Accuracy (Total Effect) — ±0.01% +2 mV from +15°C to +30°C, derating to ±0.035% +3 mV at 0°C and +50°C.

Source Effect — 1 mV.

Load Effect — 500 μV for a no load to full load change in load current measured at sense terminals.

Step Size Accuracy — 0.5 mV ±0.2 mV.

PARD*1 — ≤2 mV p-p, 10 Hz to 5 MHz.

Load Transient Recovery*1 *2 — <200 μs to recover within 5.0 mV of final value from no load to full load.

**1 Characteristics measured at front panel terminals without using remote sense.*

**2 Without external energy storage components.*

CONSTANT CURRENT MODE

Range — 10 mA to 305 mA in 2.5 mA steps.

Overall Accuracy — ±2% +5 mA.

DIGITAL METER

Configuration — True 4½ digit free running voltmeter. Meter can be selected by front panel controls or via GPIB to monitor output voltage, current or current limit setting. Measurements are displayed on the front panel and are available over the GPIB.

Resolution — 1 mV or 0.1 mA.

Accuracy — Output Voltage: ±0.15% +6 mV. Output Current: ±1.5% +1 mA. Current Limit: ±1.5% +5 mA.

Reading Rate — ≈5/s.

IEEE-488 1978 Interface Function Subsets Implemented — SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.

OTHER CHARACTERISTICS

Isolation Voltage (Maximum Allowable Voltage Between Any Output or Sense Terminal and Chassis Ground) — 42 V peak ac + dc.

TM 5000 Power Module Compatibility — The PS 5004 is not compatible with TM 500 mainframes.

INCLUDED ACCESSORIES

Instruction manual; reference guide.

Order PS 5004 Precision Power Supply **$1,250**

GPIB IEEE-488 PS 5010

The PS 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Dual Floating Supplies 0 to 32 V, to 0.75 A (1.6 A to 15 V)

Logic Supply +4.5 to 5.5 V, to 3 A

0.5% Accuracy

Programmable Current Limits

Three Independent Digital Displays

Automatic Crossover

The PS 5010 Programmable Power Supply provides a complete and rapid high performance solution for many system power supply applications. Its three supplies provide the most commonly used voltages, and the three digital displays automatically indicate all six voltage and current limit parameters. Automatic crossover from voltage to current limit and a powerful set of GPIB status reporting messages allow the user to be constantly aware of the PS 5010's status.

The PS 5010's dual floating supply provides 0 to +32 V and 0 to −32 V, both with respect to a common front-panel terminal. Or 0 to 64 V across the terminals of both supplies together—with currents up to 0.75 A throughout the total voltage range and 1.6 A below 15 V. The logic supply provides +4.5 to +5.5 V with respect to ground, with currents to 3 A. The user can program the outputs on and off, and can lock out the front panel controls with GPIB commands.

The three supplies can be independently programmed for separate voltage and current limits, and displayed in the LED display. Whenever a load change causes a supply to change modes from constant voltage to constant current (or vice versa), the corresponding display also changes to show the known current or voltage value. This condition can be reported over the GPIB via an interrupt when the PS 5010 is in the remote state.

CHARACTERISTICS

POSITIVE AND NEGATIVE FLOATING SUPPLIES

Configuration — Dual floating with shared common terminal.

Isolation — 150 V peak front panel, 42 V peak from rear interface, 0.015 μf typical shunt capacitance to ground.

Voltage Range — 0 to +32.0 V; 0 to −32.0 V.

Voltage Accuracy — ±(0.5% + 20 mV) overall; ± (0.01% +2 mV) line regulation; ±10 mV for 1 A load current change (1 mV when using rear interface output with remote sensing).

Voltage PARD (Ripple and Noise) — 10 mV p-p; 20 Hz to 20 MHz.

Voltage Resolution — 10 mV ±10 mV (typ ±2 mV) to 10.0 V. 100 mV ±40 mV (typ ±10 mV) >10.0 V.

Load Transient Recovery — 500 μs to recover within 20 mV of nominal value for a 1 A change.

Voltage Change Response Time — 1 ms for up or down change with maximum load, 20 ms for down change with no load.

Current Range — 50 mA to 0.75 A (1.60 A at 15 V and below) in high power compartment; 50 mA to 400 mA (0.750 A at 15 V and below) in two standard power compartments.

Current Accuracy — ±(5% + 20 mA) overall; ±1 mA line regulation; ±10 mA load regulation. Output impedance is typically 5 kΩ shunted by 20 μF.

Current Mode PARD (Ripple and Noise) — 10 mA p-p, 20 Hz to 20 MHz.

Current Change Response Time — 20 ms up or down.

Current Resolution — 50 mA ±15 mA.

LOGIC SUPPLY

Voltage Range — +4.50 to +5.50 V, ground referenced.

Voltage Accuracy — ±50 mV overall; ±1 mV line regulation; ±10 mV for 1 A load current change (1 mV when using rear interface output with remote sensing).

Voltage PARD (Ripple and Noise) — 10 mV p-p, 20 Hz to 20 MHz.

Voltage Resolution — 10 mV ±10 mV (typ ±2 mV).

Load Transient Recovery — 500 μs to recover within 20 mV of nominal value.

Current Limit Range — 100 mA to 3.0 A (Foldback characteristic below 4.5 V, maximum short circuit current is <1.5 A).

Current Limit Accuracy — ±(5% +20 mA).

Current Resolution — 100 mA ±30 mA.

Scaled Current Output — 10 mA = 1 mV ±(2% +2 mV) available at rear interface (not ground referenced).

Overvoltage Protection — SCR crowbar typically trips at 6 V to 7 V.

OTHER CHARACTERISTICS

TM 5000 Power Module Compatibility — The PS 5010 is not compatible with TM 500 mainframes.

Power Consumption — 250 VA maximum in high power compartment, 200 VA in standard compartment.

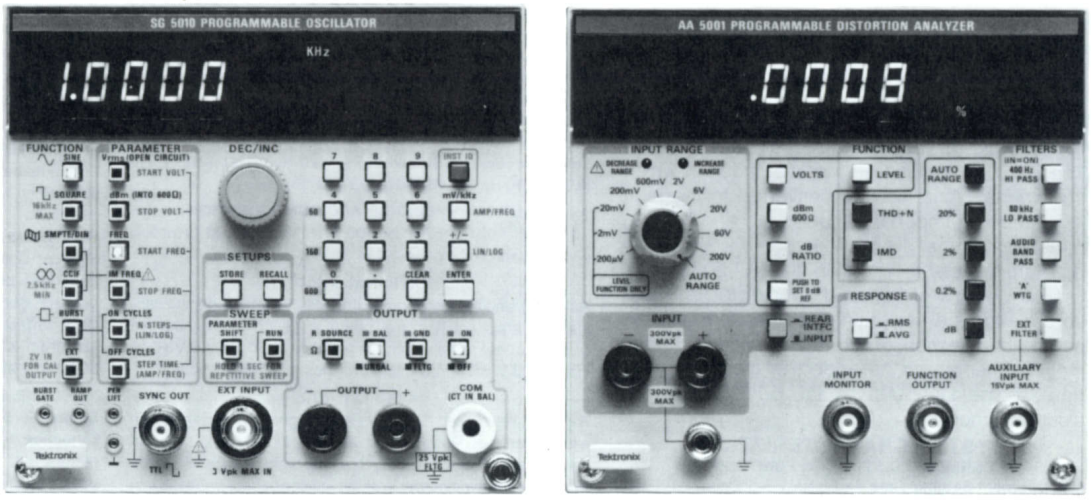
Included Accessories — Instruction manual; reference guide.

Order PS 5010 Power Supply **$2,820**

Utility Software **$150**

Refer to page 330 for description and ordering information.

SG 5010/AA 5001



Programmable Audio Test System

GPIB IEEE-488

NEW SG 5010/AA 5001

The SG 5010 and AA 5001 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Fast, Accurate, Repeatable Measurements

Lower Required Operator Skill

Automatic Low-Cost Documentation of Test Results

Automated Audio Test System Advantages

Tektronix SG 5010 and AA 5001 programmable instruments in a computer-controlled test system will make critical audio measurements consistently, accurately, and in two to four seconds each. Even complex tests can be made by technically unskilled operators since the procedures are controlled by software in the controller. And, permanent graphic or tabular records of test results can be produced at very low cost.

An SG 5010/AA 5001 based system will automatically perform such industry-standard tests as harmonic distortion to IHF A202, intermodulation distortion to SMPTE TH 22.51, DIN 45403, IEC 268.3, and IHF A202, frequency response to IHF A202, and noise or signal-to-noise ratio to IHF A202 ("A" weighting filter complies with ANSI specification S1.4 and IEC specification 179 for sound level meters). With the Option 02 capability of the AA 5001, noise measurements may be made to CCIR 468-2 and DIN 45405 standards. The SG 5010 also generates the burst signal necessary for dynamic headroom tests per IHF A202.

A basic automated system consists of the SG 5010 Programmable Oscillator, the AA 5001 Programmable Distortion Analyzer, and an IEEE-488 controller such as the Tektronix 4041 or 4050 Series. Frequency counters, signal switchers, interface devices, disc storage, and hard copy units or plotters may be optionally added to the system.

Typical Applications

One ideal application for automated audio testing is the moderate-to-high volume production line for consumer and professional audio equipment. Test results can be economically logged or printed for files or the customer. In the engineering laboratory, characterization of complex variable devices such as parametric equalizers can be greatly speeded with automatic test equipment, and the Tektronix 4695 color plotter or 4662 eight-color plotter can quickly produce highly legible results. Audio tape recorders and the audio channels of video tape, cassette, and disc machines may be tested with no special synchronization required, as can earth stations and radio networks when a stepped tone signal is available. Performance levels of the SG 5010/AA 5001 system are consistent with new 16-bit digital system noise and distortion levels. Radio and TV broadcasting stations and networks can automate proof-of-performance tests, even running them daily at sign-on or sign-off to maintain signal quality control. Highly complex devices, such as large recording consoles with multiple inputs and outputs or large audio switchers, may be impractical to test with manual techniques and truly maintainable only via automation. Loudspeakers and microphones can be automatically characterized by the addition of reference transducers and pre-amplifiers to the system. Swept pre-emphasis, de-emphasis, or equalized signals can be easily generated since the controller has full control over both frequency and amplitude.

Other Measurement Capabilities

Features and flexibility of the SG 5010 and AA 5001 permit a variety of other measurements to be easily automated. SMPTE-like IMD measurements may be made at a variety of lower frequencies and any value of upper frequency, and at 1:1 amplitude ratios in addition to the standard 4:1 ratio. A CCIF test with the frequencies selected near the upper band limit of the device under test has been shown to be a very effective and simple-to-implement test for transient or dynamic intermodulation (TIM and DIM). Burst signals of any desired duty cycle may be generated for IHF dynamic headroom measurements and to test

NEW

compressors and limiters; the between-bursts level may be selected as Off or 20 dB below the burst level. Power measurements are made by a controller computation from a voltage measurement across a known load resistance. SINAD measurements of sensitivity of FM communications receivers are a standard capability of the AA 5001 plus an appropriate RF signal generator. The SG 5010 features an amplifier mode in which an external signal can be converted to the high level, multiple impedance, balanced and floating capability of the SG 5010 output circuitry. Fully program-selectable filters in the AA 5001 allow various choices of bandwidth for distortion measurements and weighting for noise measurements, or rejection of interfering signals. Phase measurements can be added to the system by use of the DC 5009 or DC 5010 Universal Counter-Timer.

SYSTEM CHARACTERISTICS

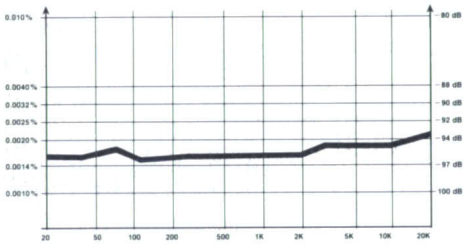
HARMONIC DISTORTION FUNCTION

Measurement Settling Time — Typically ⩽3 s above 100 Hz, 5 s below 100 Hz.

Residual THD + N — V_{in} ⩾250 mV, RMS response, all distortion, noise, and nulling resources combined. 20 Hz to 20 kHz ⩽0.0032% (−90 dB) with 80 kHz filter. 10 Hz to 100 kHz ⩽0.01% (−80 dB) no filters.

TYPICAL SYSTEM RESIDUAL THD + NOISE

V_{in} ⩾250 mV with 80 kHz filter, RMS response.



INTERMODULATION DISTORTION FUNCTION

Measurement Settling Time — Typically ⩽2 s.

Residual IMD — V_{in} ⩾250 mV, RMS response.

SMPTE and DIN Tests — ⩽0.0032% (−90 dB) for 60 Hz and 7 kHz or 250 Hz and 8 kHz, 4:1 ratio.

CCIF Difference Frequency Test — ⩽0.0018% (−95 dB) with 14 kHz and 15 kHz.

LEVEL FUNCTION

Measurement Settling Time — Typically ⩽2 s.

Flatness — ±0.1 dB 20 Hz to 20 kHz.

SG 5010 CHARACTERISTICS

AVAILABLE FUNCTIONS

Sinewave, squarewave, SMPTE/DIN 4:1, SMPTE/DIN 1:1, CCIF, Sinewave Burst, IHF Burst (−20 dB or Off between bursts), External Input (Amplifier Mode).

FREQUENCY RANGE AND ACCURACY

Sinewave, Sinewave Burst

SMPTE/DIN: 10 Hz to 163.80 kHz ±0.01%.

CCIF Center Frequency: 2.500 kHz to 163.80 kHz ±0.01%.

Squarewave: 10 Hz to 16.380 kHz ±0.01%.

Resolution in Above Functions

10.00 Hz to 163.80 Hz: 0.01 Hz. 163.9 Hz to 1.6380 kHz: 0.1 Hz. 1.639 kHz to 16.380 kHz: 1.0 Hz. 16.39 kHz to 163.80 kHz: 10.0 Hz.

SMPTE Lower Tone, CCIF Offset From Center Frequency — Selectable From: 40 Hz, 50 Hz, 60 Hz, 80 Hz, 100 Hz, 125 Hz, 250 Hz, 500 Hz, all ±2%.

Sine Distortion (Load ⩾600 Ω, THD Including 2nd Through 5th Harmonics) — 20 Hz to 20 kHz: 0.001% (−100 dB). 20 kHz to 50 kHz: 0.0032% (−90 dB). 10 Hz to 20 Hz and 50 kHz to 100 kHz: 0.01% (−80 dB). 100 kHz to 163.8 kHz: 0.032% (−70 dB) any individual harmonic.

SMPTE, DIN or CCIF Distortion — See System Specifications.

Sine Flatness — 20 Hz to 20 kHz: ±0.05 dB. 10 Hz to 163.8 kHz: ±0.2 dB.

Squarewave Risetime — 1.5 μs ±10%.

Burst Range — 1 to 65535 cycles On. 1 to 65535 cycles Off. Off level either −20 dB or zero. All switching at sinewave zero crossing. Triggered, gated, or free-running burst modes available.

OUTPUT LEVEL RANGE AND ACCURACY

Balanced — Into Open Circuit: 200 μV to 21.2 V RMS. Into 600 Ω: −72.45 dBm to +28.45 dBm.*1

Unbalanced — Into Open Circuit: 200 μV to 21.2 V RMS. Into 600 Ω: −72.45 dBm to +22.05 dBm.*1

*1 *R_S = 50 Ω. For R_S = 150 Ω, subtract 1.25 dBm; for R_S = 600 Ω, subtract 5.35 dBm.*

Resolution — 0.05 dB in dBm mode, 0.25% or better in volts mode.

Level Accuracy (Sinewave) — 20 Hz to 20 kHz ±2% (0.2 dB). 10 Hz to 163.8 kHz ±3 (0.3 dB).

OUTPUT IMPEDANCE AND CONFIGURATION

50 Ω ±3%, 150 Ω ±2%, or 600 Ω ±1%, balanced or unbalanced, floating or grounded.

EXTERNAL INPUT

A floating single-ended input is provided for accessing the variable gain stage and high level output amplifier, enabling the use of custom test signals. Input impedance is 20 kΩ; a 2 V RMS input (2.83 V peak maximum) provides a calibrated output.

SYNC OUTPUT

A ground referenced TTL compatible signal is provided which allows stable oscilloscope display of all functions. In sine and squarewave modes the output is at the signal frequency. In the IM modes the sync output is at the lower or offset frequency. In both burst modes the sync signal follows the burst envelope.

SWEEP MODE

Linear or logarithmic sweep of amplitude or frequency in any function. Sweep is composed of discrete steps. The following sweep functions are programmable via GPIB or from the front panel: swept parameter (frequency or amplitude), linear or log sweep, number of steps up to 99, time per step from 0.1 s to 25 s, start frequency or voltage, and stop frequency or voltage. Start and stop frequencies or voltages may be anywhere within the range of the generator, and sweep direction may be upward or downward. Pen lift and ramp outputs are available for interface to an analog plotter.

STORED SETUPS

Ten different complete front panel setups may be stored in the nonvolatile internal memory and recalled from front panel push buttons or via the GPIB. Additionally, the front panel settings at power down are retained and used at power up.

PROGRAMMABILITY

All functions, parameters, and modes may be controlled over the GPIB using simple English-like commands. All settings may be interrogated, with the resulting response usable as a command to return the instrument to that setting (Learn mode). The GPIB address may be displayed and changed from the front panel.

GPIB Interface Function Subsets Implemented — SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.

AA 5001 CHARACTERISTICS

HARMONIC DISTORTION FUNCTION

Fundamental Frequency Range — 10 Hz to 100 kHz, automatically tuned to input frequency.

Distortion Ranges — Auto (100%), 20%, 2%, 0.2%, and dB (autoranging).

Accuracy — 20 Hz to 20 kHz is ±1 dB. 10 Hz to 100 kHz is +1, −2 dB. (Accuracy is limited by residual THD + N and filter selection.)

Fundamental Rejection — At least 10 dB below specified residual THD + N or actual signal THD, whichever is greater.

Minimum Input Level — 60 mV (−22 dBm).

LEVEL FUNCTION

Autoranging digital voltmeter displays input signal level in volts, dBm, or dB ratios.

Modes — Volts, dBm (600 Ω), or dB ratio with push-to-set 0 dB reference.

Level Ranges — 200 μV full scale to 200 V full scale in ten steps, manual or autoranging.

Accuracy

Frequency	Volts	dBm or dB Ratio
20 Hz to 20 kHz	±2% +1 count	±0.3 dB +0.01 of dB reading
10 Hz to 100 kHz	±4% +2 counts	±0.5 dB +0.01 of dB reading

Bandwidth — ⩾300 kHz.

Residual Noise —

⩽3 μV (−108 dBm) with 80 kHz and 400 Hz filters, RMS response.

⩽1.5 μV (−114 dBm) with "A" weighting filter, RMS response (standard instrument only).

⩽5 μV (−104 dBm) with CCIR weighting filter, quasi-peak response (Option 02 instrument only).

INTERMODULATION DISTORTION FUNCTION

Fully automatic SMPTE, DIN, and CCIF difference tone measurements. Minimum input level 60 mV (−22 dBm). Accuracy ±1 dB.

SMPTE and DIN Tests — Lower Frequency Range: 50 Hz to 500 Hz. Upper Frequency Range: Usable from 3 kHz to 163.8 kHz. Level Ratio Range: 1:1 to 4:1 (lower:upper). Residual IMD: See System Specifications.

CCIF Difference Frequency Test — Frequency Range: Usable from 4 kHz to 163.8 kHz. Difference Frequency Range: 80 Hz to 1 kHz. Residual IMD: See System Specifications.

ALL FUNCTIONS

Display — 3½ digits resolution at ≈3 readings/s.

Detection — Average or true RMS for waveforms with crest factors ⩽3. Option 02 replaces average detector with quasi-peak detector complying with CCIR Recommendation 468-2 and DIN 45405.

Filters

400 Hz High Pass: −3 dB at 400 Hz ±5%: 18 dB/octave slope, at least 40 dB rejection at 60 Hz.

80 kHz Low Pass: −3 dB at 80 kHz ±5%; 18 dB/octave slope.

22.4 Hz to 22.4 kHz Bandpass: Complies with CCIR Recommendation 468-2 and DIN 45405.

"A" Weighting: Meets specifications for type one sound level meters (ANSI S1.4, IEC Recommendation 179). Option 02 replaces "A" weighting filter with CCIR weighting filter complying with CCIR Recommendation 468-2 and DIN 45405.

Ext: Allows connection of external filters.

Input Type — Balanced (full differential).

Input Impedance — 100 kΩ ±2%, each side to ground.

Maximum Input — 300 Vpk, 200 V RMS either side to ground or differentially. Fully protected on all ranges.

Common-Mode Rejection — ⩾50 dB at 50 or 60 Hz. Typically ⩾40 dB to 300 kHz.

PROGRAMMABILITY

Function (Level or THD or IMD). Level Mode (Volts or dBm). Input Level and Distortion Ranges (Autorange or default to range selected by front panel switches).

Detector Type (RMS or AVG; or RMS or Q-PK on Option 02). Filter Selection (400 Hz Hi Pass, 80 kHz Low Pass, 22.4 Hz to 22.4 kHz Band-Pass, "A" Weight (or CCIR WTG on Option 02, Ext Filter).

GPIB Interface Function Subsets Implemented — SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT0, C0.

FRONT PANEL SIGNALS

Input Monitor — Provides constant amplitude version of signal applied to input. Output Voltage: 1 V RMS ±10% for input signals >50 mV. Source Impedance: 1 kΩ ±5%.

Function Output — Provides a scaled sample of selected function signal. Output Voltage: 1 V RMS ±3% for 1000 count display. Source Impedance: 1 kΩ ±5%.

Auxiliary Input — Provides input to detector circuit when Ext Filter button is depressed. Sensitivity: 1 V RMS ±3% = 1000 count display. Impedance: 100 kΩ ±5%, ac coupled.

REAR INTERFACE SIGNALS

Duplicates of all front panel inputs and outputs are provided to allow external filter connections or oscilloscope monitoring within same mainframe without exposed cables. Detector outputs with specified scale factors also available to drive analog chart recorders, storage oscilloscopes, or similar devices.

INCLUDED ACCESSORIES (SG 5010/AA 5001)

Instruction manual; reference guide.

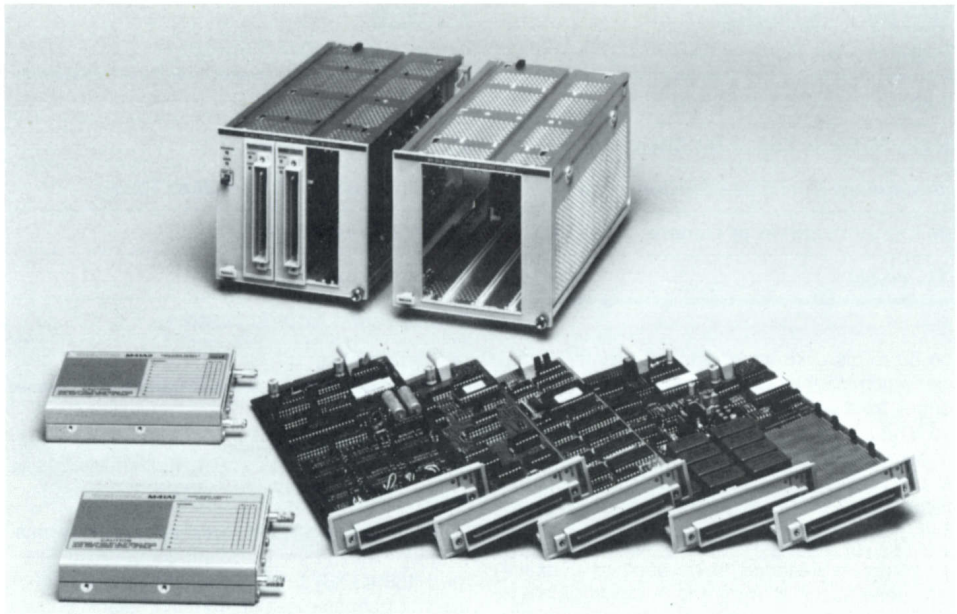
ORDERING INFORMATION

SG 5010 Programmable Oscillator **4,000**

AA 5001 Programmable Distortion Analyzer **3,300**

Option 02 — CCIR/DIN ..... **+$400**

AUDIO TEST SYSTEM



Multifunction Interface System

GPIB IEEE-488 MI 5010 MX 5010

The MI 5010 and MX 5010 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Wide Range of System Interfacing Functions

Up to Six Functions at One Address

D-to-A, A-to-D Conversion

Low-Level Signal Scanning

Digital I/O

Digital Word Acquisition and Generation

Built-In Time-of-Day and Pacing Clock

Command Buffer for Controller-Free Operation

The MI 5010/MX 5010 Multifunction Interface System consists of the MI 5010 Multifunction Interface, the MX 5010 Multifunction Interface Extender, and seven different types of function cards. These cards are capable of a variety of functions typically required in automated test system interfacing, data acquisition and generation, and process control.

The MI 5010 and MX 5010 each house up to three function cards, in any combination. The MI 5010 provides the means of communication between the system controller and the function cards. The MX 5010 is always used in connection with an MI 5010, extending its control to six function cards at one GPIB address.

The function cards presently available for the MI 5010/MX 5010 Multifunction Interface System are: 50M10 Analog-to-Digital Converter, 50M20 Digital-to-Analog Converter, 50M30 Digital I/O, 50M40 Relay Scanner, 50M41 Low-Level Scanner (with M41A1 through M41A8 Signal Conditioners), 50M50 Memory, and 50M70 Development card. Each function card contains its own ROM with the specific firmware and its own unique set of commands required for its particular function. Each card may be operated in any slot of the MI 5010 and/or MX 5010 regardless of the other cards in the system.

In addition to providing the interface between the function cards and the system controller, the MI 5010 also has its own intelligence and a built-in command buffer. This buffer is capable of storing up to 300 system commands and executing them in sequence, paced by the on-board time-of-day and pacing clock or by signals from the system under test. It requires no interference from the system controller, thus freeing the controller to direct activity elsewhere in the system.

IEEE-488 1978 Interface Function Subsets Implemented — SH1, AH1, T6, L4, SR1, RL0, PP0, DC1, DT1, C0.

Included Accessories — Instruction manual; reference guide.

ORDERING INFORMATION

MI 5010 Multifunction Interface **$1,625**

MX 5010 Interface Extender **$685**

NEW 50M41

Programmable Low-Level Scanner

10 Differential Contact Pairs Plus Guard

<1 μV Low Thermal Offset

User Configurable

Handshake Lines to Permit External Control

Isothermal Amplifiers Available for Thermocouple Applications

The 50M41 provides ten pairs of guarded, normally open relay contacts with less than one microvolt of thermal offset in each channel. Each differential pair of contacts is accompanied by a third contact to switch the shield or guard connection. The ten sets of relay contacts can be configured as two groups of five individual relays with two commons, or as one group of ten individual relays with one common. The desired relay switch pattern is configured by internal jumpers. A tree relay can be included in the 1-of-10 configuration to reduce capacitive loading and potential noise problems when using more than one 50M41 in a system. Two handshake lines are provided for externally controlling the 50M41.

A family of high-gain, low-noise signal conditioning modules—M41A1 through M41A8—is available to condition low-level signals for specialized applications with the 50M41. The M41A1 is a general purpose amplifier with switchable gain in decade steps from 1 to 1000. Provision is made for a guarded input that can be driven by the amplifier's guard driver or by an external signal source. A software selectable low-pass filter with a corner frequency of approximately 4 Hz provides more than 60 dB of normal mode rejection at 60 Hz. The frequency response with the filter turned off is approximately 10 kHz.

Signal conditioning modules M41A2 through M41A8 are thermocouple amplifiers, each designed to operate with a specific thermocouple type (J, K, E, T, S, R, and B, respectively). The thermocouple amplifier provides isothermal connections for up to ten guarded or unguarded thermocouple pairs. Each amplifier provides hardware compensation for its specific thermocouple type; provision for software compensation is made where all thermocouples are not of the same type. Thermocouples are available from your local supplier.

CHARACTERISTICS

Type of Relays — 10 sealed low-thermal-EMF relays configurable as one 10-to-1 switch or two 5-to-1 switches.
Thermal Offset — <1 μV differential; <2 μV differential with tree switch.
Maximum Scan Rate — ⩾200 cycles/s.
Maximum Applied Voltage (High, Low or Guard of Any Channel to Chassis) — 350 V dc + peak ac.
Maximum Switched Voltage — 150 V dc + peak ac (not to exceed VA rating).
Maximum Carry Current — 250 mA.
Maximum Switched Current — 10 mA.
Maximum Switched VA — 0.15 VA.
Included Accessories — Instruction manual; reference guide.

Order 50M41 Low Level Scanner Card **$995**

Utility Software **$150**

Refer to page 330 for description and ordering information.

NEW 50M10

Programmable A/D Converter

12-Bit Resolution

30,000 Conversions Per Second

Four Voltage Ranges ±100 mV to ±100 V

Data Transfer via GPIB or Front Panel Connector

The 50M10 uses a 12-bit successive approximation conversion technique with a track-and-hold amplifier to achieve a total conversion time of 32 microseconds or less (approximately 30,000 conversions per second). Using the front panel connector, conversion values may be sent over the GPIB (via the MI 5010) or to external memory devices (such as the 50M50 Memory card). In either case, data is transferred in two eight-bit bytes. The lower six bits contain the converted value, high byte followed by low byte. The seventh bit is a high-low byte indicator. The eighth bit is unused.

Four voltage ranges are provided, manually selectable by on-board jumpers: +100 mV, +1 V, +10 V and +100 V. The total span for each range is divided into 4096 parts (12 bits). The front panel analog input connections (high and low) may be elevated to a potential of +340 volts, dc plus peak ac.

Two handshaking modes are provided, one for communication with devices faster than the 50M10 (the device can accept data as fast as the 50M10 can provide it), and the other for communication with devices slower than the 50M10 (the 50M10 must be clocked by the external receiving device). Front panel control lines permit the 50M10 conversions to be triggered, gated, or triggered within a gate. Through the use of a gateable function generator, such as the Tektronix FG 501A, and a digital delay generator, such as the Tektronix DD 501, a counted burst of conversions at a selected rate can be gated.

CHARACTERISTICS

Maximum Conversion Rate — ≥30,000/s.

Maximum Aperture Time — ≥400 Ns.

Accuracy

Range	18°C to 28°C	0°C to 50°C
100 mV	±0.15%*1	±0.25%*1
1 V and 10 V	±0.075%*1	±0.125%*1
100 V	±0.125%*1	±0.2%*1

*1 *Full scale.*

Amplifier Settling Time — 100 mV Range: ≤150 μs. 1 V Range: ≤25 μs. 10 V Range: ≤10 μs. 100 V Range: ≤30 μs.

Input Impedance — 100 mV, 1 V and 10 V Ranges: $\geq 10^{10}$ Ω. 100 V Range: ≥1 MΩ.

INCLUDED ACCESSORIES

Instruction manual; reference guide.

Order 50M10 Analog-to-Digital Converter Card **$850**

Utility Software **$150**

Refer to page 330 for description and ordering information.

NEW 50M50

Programmable Memory Card

16 kbyte Digital Input/Output

Single 16-Bit or Dual 8-Bit Channels

Independent Dual-Channel Operation

200 kHz Acquisition or Generation Rate

TTL Levels

The 50M50 is a 16 kbyte digital input/output device which can be configured, under program control, as a single 16-bit input/output port or as two 8-bit input/output ports. These ports can be connected to any of 16 data buffers which can be programmed to different lengths. The total memory of all the buffers cannot exceed 16 kbytes of storage.

The 50M50 is intended to be used as a digital word generator and/or as a fast, digital data acquisition buffer. As a digital word generator, the 50M50 can be used with a digital-to-analog converter, such as the Tektronix 50M20, to function as an arbitrary waveform generator. As a high speed data acquisition buffer, the 50M50 can be used with an analog-to-digital converter, such as the Tektronix 50M10, as an off-line, high-speed analog signal measurement system or as a waveform digitizer.

The 50M50 can be programmed to input or output data on two different channels simultaneously, or to input data on one channel while outputing data on the other channel. System commands to the 50M50 control the selection of input/output channels, the control of the data buffers, and the arming functions of the card.

Four handshake lines are provided at the front panel to permit synchronization with the user's external system (one pair for each channel). Other external control lines permit pacing and control of data output and disabling of data input.

CHARACTERISTICS

Data Outputs — 8 or 16 low-power Schottky TTL lines. Logical "1": +5 V ±2% (open circuit). Source current is 2.5 mA +2% −7% maximum. Logical "0": ≤0.7 V. Sink current is 40 mA maximum.

Data Inputs — 8 or 16 low-power Schottky TTL lines. Logical "1" (+V Threshold): +1.5 to +2 V. Source current is −0.16 mA maximum. Logical "0" (−V Threshold): +0.6 V to +1.1 V. Source current is −0.21 mA maximum.

Maximum Data Transfer Rate — 8-Bit Bytes: 200 kHz ±2%. 16-Bit Bytes: 125 kHz ±2%.

INCLUDED ACCESSORIES

Instruction manual; reference guide.

Order 50M50 Memory Card **$950**

Utility Software **$150**

Refer to page 330 for description and ordering information.

50M20

Programmable D/A Converter

12-Bit Resolution

Voltage or Current Mode

20 μs (Maximum) Conversion Time

250 V RMS Isolation

Mnemonic Instructions

Self-Test and Error Indicators

UL 1244 Listed

The 50M20 converts digital data to either analog voltage or current. The voltage or current mode is selectable manually via an on-board switch.

Data format is 12 bits, sent in two sequential 7-bit words. Data may be sent via the IEEE Standard 488 (GPIB) using the MI 5010 as the interface, or from an external (front connector) bus for high speed data transfer (with appropriate handshake lines). On-board firmware will convert commands and data to the proper format to perform the required digital-to-analog conversion. Two lines at the front panel connector are provided to handshake data into the 50M20 from the user's external system.

Programming of the 50M20 is via the IEEE-488 (GPIB) bus. System commands sent to the MI 5010 microprocessor, along with specialized programming commands unique to the 50M20, control the source and the format of the digital data. The 50M20 may be programmed to respond to either external or internal system triggers.

CHARACTERISTICS

VOLTAGE MODE

Range — −10.240 V to +10.235 V.

Accuracy — ±10.0 mV (+20°C to +30°C) ±15 mV (0°C to +50°C).

Resolution (1 LSB) — 5 mV.

Total Conversion Time (Maximum) — 20 μs.

Output Ripple and Noise — <5 mV p-p at 5 MHz BW.

Output Current Range — 0 mA to ±5 mA.

CURRENT MODE

Range — −20.48 mA to +20.47 mA.

Accuracy — ±20 μA (+20°C to +30°C) ±40 μA (0°C to +50°C).

Resolution (1 LSB) — 10 μA.

Total Conversion Time (Maximum) — 20 μs.

Output Ripple and Noise — <15 μA, p-p, at 5 MHz BW.

Compliance Voltage — ±11 V.

Isolation — 250 V RMS maximum to ground.

INCLUDED ACCESSORIES

Interfacing cable (015-0430-00); instruction manual; reference guide.

Order 50M20 Digital-to-Analog Converter Card **$835**

Utility Software **$150**

Refer to page 330 for description and ordering information.

50M30

Programmable Digital Input/Output Card

16 Digital Input and 16 Digital Output Lines

Data Entry/Output Formats in Decimal, Binary, or Hex

Triggered Externally or On Command

Mnemonic Instructions

Self-Test and Error Indicator

UL 1244 Listed

The 50M30 provides 16 digital input and 16 digital output lines. The digital inputs accept data from pushbuttons, switches, contact closures, and most digital devices capable of supplying TTL output levels. The digital outputs provide TTL levels to control various types of test and measurement instruments, relays, indicators, etc. The digital outputs can be configured for open-collector outputs by positioning internal jumpers and using power supplied by the user.

Programming of the 50M30 is via the IEEE-488 (GPIB) bus. System commands sent to the MI 5010 Microprocessor, along with specialized programming commands unique to the 50M30, control the selection of the data input/output channels and the arming/trigger functions of the card.

Four lines at the front panel connector operate as input/output pairs to handshake data with the user's external system. One handshake pair allows the user's data source to be synchronized with the 50M30 data input register and the other handshake pair allows the user's data storage device to be synchronized with the 50M30 data output register.

CHARACTERISTICS

Data Outputs Using Internal Supply — 16 open-collector TTL with 2 kΩ pullup resistors. Logical "1": +5 V ±2% (open circuit). Source current is −2.5 mA ±7% maximum. Logical "0": 0.2 V. Sink current is −40 mA maximum.

Data Outputs Using External (User) Supply — Maximum Voltage: +15 V. Pullup Resistors: 2 kΩ. Logical "1" equal to external supply voltage (open circuit). Source current is 7.5 mA ±5% plus external supply tolerance. Logical "0": 0.2 V. Sink current is 40 mA maximum.

Data Inputs — Input Buffers: 16 Schmitt triggers. Logical "1" (+V Threshold): +1.6 V ±25%. Source current is −0.14 mA nominal, −0.16 mA maximum. Logical "0" (−V Threshold): +0.8 V ±40%. Source current is −0.18 mA nominal, −0.21 mA maximum.

INCLUDED ACCESSORIES

Interfacing cable (015-0430-00); instruction manual; reference guide.

Order 50M30 Digital Input/Output Card **$450**

Utility Software **$150**

Refer to page 330 for description and ordering information.

50M40

Programmable Relay Scanner Card

16 Mercury Wetted Relay Contacts

User Configurable

1	1 of 16
2	1 of 8
4	1 or 4

Triggered Externally or On Command

Mnemonic Instructions

Self-Test and Error Indicators

UL 1244 Listed

The 50M40 provides 16 independent, normally-open relay contacts. The relay contacts may be used as switch closures to supply power to several external points from one source, or scan several sources and supply various inputs to a single measurement device.

The desired relay switch pattern is configured by the user with internal jumpers. When the configuration has been established, the relay scanning sequence, open and close operations, and triggering events are programmed over the IEEE-488 GPIB bus.

Two logic signal lines on the front panel connector are provided for externally controlling the 50M40—one as an output (Ready) to indicate to the user when the relays have settled, and the other as an input (Ext Trig) to tell the MI 5010 Microprocessor that the user is ready for the relay switch configuration to close. Three possible configurations are:

4 groups of 4 individual relays
2 groups of 8 individual relays
1 group of 16 individual relays

Scanning sequence and relay closure is accomplished under program control. Two logic signal lines on the front panel connector are provided for externally controlling the 50M40—one as an output (Ready) to indicate to the user when the relays have settled, and the other as an input (Ext Trig) to tell the MI 5010 Microprocessor that the user is ready for the relay switch configuration to close.

CHARACTERISTICS

Type of Relays — Mercury wetted reed.

Possible Configurations (Jumper Selectable) — 1 of 4, 4 each. 1 of 8, 2 each. 1 of 16, 1 of 12 and 1 of 4, 1 each. Pull In Time: 3 ms, nominal. 30 V connected to common port through 30 kΩ. Release Time: 3 ms, nominal. Sequence through all relays. Contact Resistance: 0.5 Ω nominal (end of life). Peak Applied Voltage: 40 V, maximum. Peak Contact Current: 1 A, maximum. Breakdown Voltage: 100 V dc plus peak ac. Frequency Range: Dc to 1 MHz.

INCLUDED ACCESSORIES

Interfacing cable (015-0430-00); instruction manual; reference guide.

Order 50M40 Relay Scanner Card **$635**

Utility Software **$150**

Refer to page 330 for description and ordering information.

50M70

Programmable Development Card

32 Data I/O Ports

Interrupt and Trigger Lines

Vector Board Development Region

Mnemonic Instructions

Self-Test and Error Indicator

The 50M70 provides the user with the means of developing his own unique circuit and interfacing it to the GPIB without the need for designing and building the GPIB interface itself. With the 50M70, the user may create a specialized function card to be used in the MI 5010/MX5010 Multifunction Interface System. When completed, the circuit can be programmed in high level language over the GPIB.

The 50M70 contains two 68B21 16-bit interface logic registers (PIAs), address and data buffers, its own firmware, and a 4x4-inch breadboard area for circuit development. The 32 data lines of the PIAs can be individually programmed as inputs or outputs. The PIAs also provide three sets of programmable two-wire handshake lines to permit triggering of the external system by the 50M70 or of the 50M70 by the external system.

Typical 50M70 applications are specialized A/D and D/A converter functions, counter/timer applications, special communication interface functions, keyboard and display functions, digital comparators for triggering and interrupt functions, etc.

CHARACTERISTICS

Data Input/Outputs and Handshake Lines — Output High Level: +2.4 V minimum, +5.5 V maximum. Maximum Load Current: −200 μA. Output Low Level: 0 V minimum, +0.4 V maximum. Maximum Sink Current: 3.2 mA. Input Load Current: 1.3 mA nominal, 2.4 mA maximum.

DC Voltage Sources Available on the Card — +26 V and −26 V ±9%, 100 mA maximum; +8 V ±5%, 600 mA maximum; +5 V ±5%, 1.5 A maximum. Total Combined Power Limit: 7.5 W.

INCLUDED ACCESSORIES

Interfacing cable (015-0430-00); instruction manual, reference guide.

Order 50M70 Development Card **$370**

Utility Software **$150**

Refer to page 330 for description and ordering information.

MULTIFUNCTION INTERFACE SYSTEM OPTIONAL ACCESSORIES

Interfacing Cable — 50-conductor flat ribbon cable with connector to mate with front panel connector of any Multifunction Interface System function card. Other end of the 48-inch cable terminates in bare tinned leads. (This cable is a standard accessory with 50M20, 50M30, 50M40, and 50M70 cards.) Order 015-0430-00 ..... **$65**

Single-Width Interfacing Adaptor — Mates with any single Multifunction Interface System function card to permit customized interface wiring between cards or to external system under test. Will accommodate up to five screw terminal blocks (131-3083-00 below). Order 015-0466-00 ..... **$125**

Screw Terminal Block — Mounts in 015-0466-00 Interfacing Adaptor above to permit wiring changes without soldering (ten terminals per block). Order 131-3083-00 ..... **$9.25**

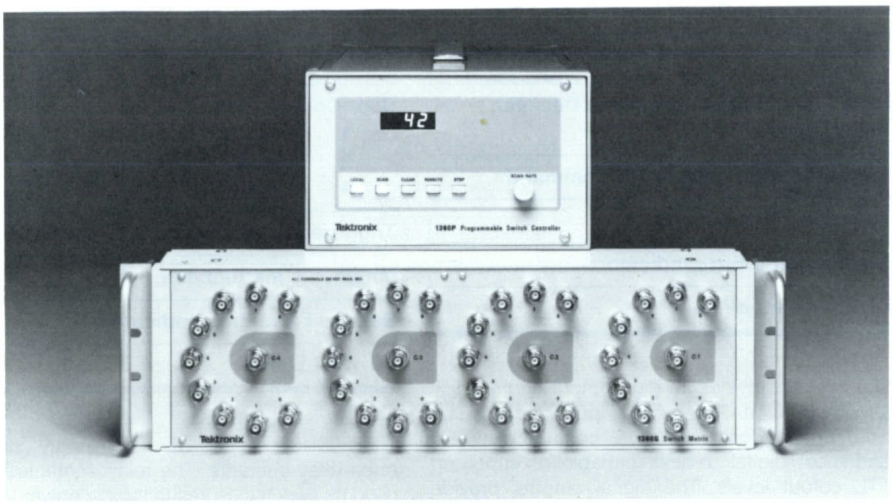
Function Card Access Shield — Dummy function card of insulating material to protect against possible electrical shock or damage in partially filled MI 5010 or MX 5010. Order 020-0836-00 ..... **$41.00**

Multifunction Interface System Card Extender — Permits operation of a function card while extended from the front of an MI 5010 or MX 5010. Order 067-1066-00 ..... **$140.00**

SI 5010

Programmable Scanner

1360P/1360S



Programmable Signal Multiplexer

GPIB IEEE-488 SI 5010

The SI 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Software Configurable as:
- **1 Group of 16 Channels**
- **2 Groups of 8 Channels**
- **4 Groups of 4 Channels**

350 MHz Bandwidth in 4-Channel Configuration

External Handshake Lines

Built-In Time-of-Day and Pacing Clock

Command Buffer for Controller-Free Operation

The SI 5010 Programmable Scanner provides the capability of switching and routing up to 16 high frequency input and/or output signals. It always maintains a clean 50-ohm environment through the use of 50-ohm coaxial reed relays. The software-configurable basic four-channel arrangement allows the SI 5010 to be used for point-to-point switching (any connector to any other connector), or to be used in a wide variety of fan-in and/or fan-out configurations.

The SI 5010 has its own intelligence and a built-in command buffer capable of storing up to 300 system commands and executing them in sequence. It is paced by the on-board time-of-day and pacing clock or by signals from the system under test. This requires no interference from the system controller, thus freeing the controller to direct activity elsewhere in the system.

Two handshake lines are provided for externally controlling the SI 5010. An Ext Trig line is provided to allow the SI 5010 switching to be initiated by the external system under test, and a Ready line indicates to the external system when the relays have settled.

CHARACTERISTICS

RF Connectors — Twenty BNC connectors, 16 channels and four commons.
Control Input (Ext Trig) — External Trigger: TTL compatible
Control Output Data Accepted (Ready) — TTL compatible. Output goes high when relays have settled.
Channel Configuration (Software Selectable) — 1, 2, 3, or 4 groups of 4 channels. 2 groups of 8 channels. 1 group of 16 channels.
Frequency Response — Any 1 Group of 4: −3 dB at 350 MHz, decreasing to −6 dB at 500 MHz or greater. Any 1 Group of 8: −3 dB at 175 MHz or greater. Any 1 Group of 16: −3 dB at 80 MHz or greater.
Port (Channel) Isolation — 40 dB at 100 MHz.
Characteristic Impedance (Each Channel) — 50 Ω. See vswr specification.
Risetime (Each Channel) — <1 ns.
Voltage Standing Wave Ratio (Vswr) — Any 4 Channel Group: 1.25:1 at 100 MHz, increasing to 1.8:1 at 350 MHz. Any Other Combination: 1.5:1 at 100 MHz. 2:1 at 225 MHz.
Insertion Loss — <1 dB at 100 MHz.
Channel Delay Matching — Any Group of 4: 50 ps. Any Group of 8: 110 ps. Any Group of 16: 310 ps.
Type of Relays — 16 Form A, EAC 05Y21A1 40 BAB, or equivalent. 4 Form "C", TO-5, Teledyne 712-6, or equivalent. Pull In Time: 3 ms. Release Time: 3 ms. Breakdown Voltage: 350 V (dc + peak ac). Series Path Resistance (End of Life): 0.5 Ω.
Peak Carry Voltage — Unterminated: 40 V maximum. 50 Ω Terminated: 12.5 V maximum.
Peak Contact Current — 0.25 A maximum.
Peak Switching Voltages — Unterminated: 15 V maximum. 50 Ω Terminated: 3.73 V maximum.
Peak Switching Current — 0.01 A maximum.
Included Accessories — Instruction manual, reference guide.

Order SI 5010 Scanner **$2,100**
Utility Software — **$150**

Refer to page 330 for description and ordering information.

GPIB IEEE-488 1360P/1360S

The 1360P/1360S comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Signal Bandwidth to 300 MHz

50 Ω Environment

Selected Pole Readout

Flexible Switch Configuration

Rackmount or Benchtop

The 1360P/1360S Programmable Signal Multiplexer is a microprocessor-based, GPIB-compatible system instrument which is used to multiplex electrical signals. The 1360P/1360S system includes two separate chassis: the 1360P Programmable Switch Controller and the 1360S Switch Matrix. The 1360P/1360S is not part of the TM 5000 Family and thus does not require a TM 5000 mainframe for operation.

The 1360P Programmable Switch Controller is controlled via the GPIB and provides all the signals required for control of up to four 1360S Switch units. The 1360P is housed in an 8.5 inch wide (half-rackwidth) rackmount chassis, with right or left slider assemblies for rackmounting.

The 1360S Switch Matrix contains four 9-to-1 switches which can be cascaded to provide two 17-to-1 switches; a 25-to-1 switch and a 9-to-1 switch; or a 33-to-1 switch. Up to four 1360S Switch units can be controlled by one 1360P Controller unit to provide up to 129-to-1 multiplexing. In the 9-to-1 configuration, the 1360S has a signal bandwidth of 250 MHz; make/break time in all configurations is <1 ms. The switches in the 1360S can also be ganged together to provide simultaneous and synchronized multiplexing of several groups of signals.

The 1360S is housed in a 5.75-inch-high, 19-inch-wide rackmount chassis three inches deep.

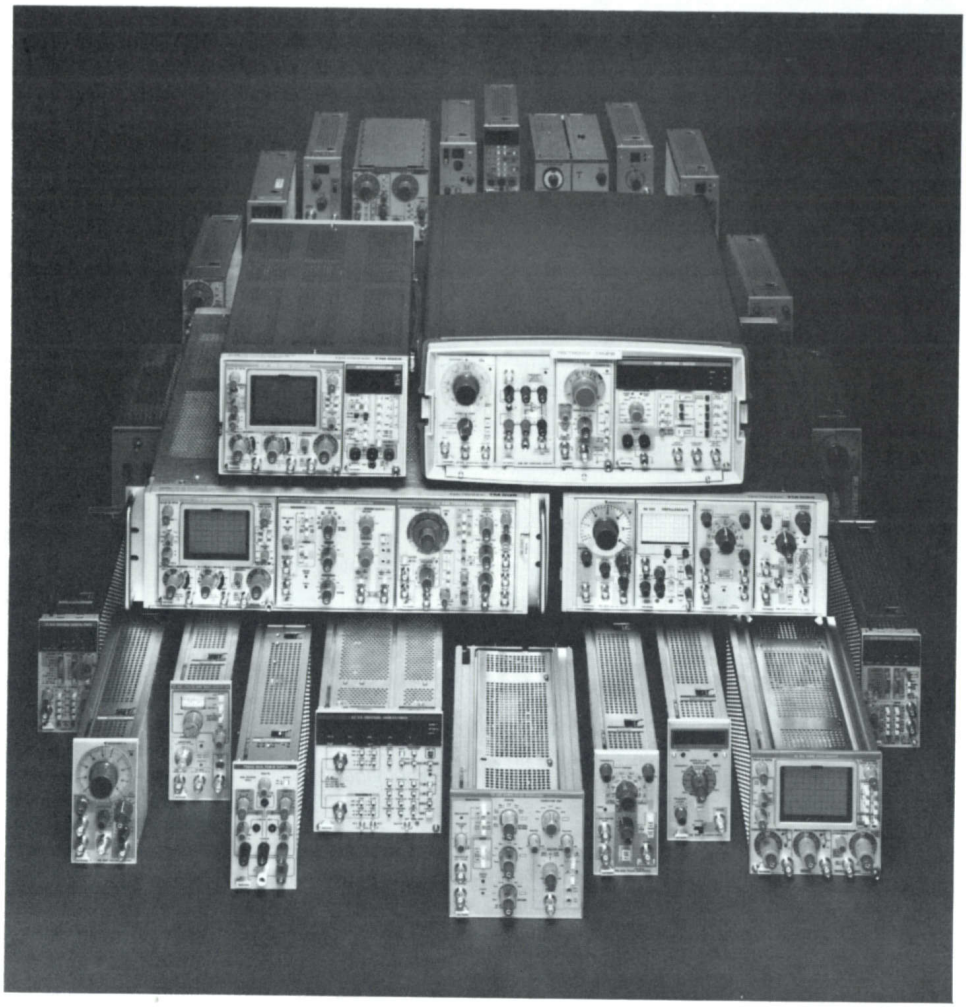
CHARACTERISTICS

Bandwidth (3 dB—Through One Switch Only) — Dc to 300 MHz.
Max Input Voltage — 250 V dc + peak ac (not to exceed 10 VA).
Max Carry Current — 250 mA (not to exceed 10 VA).
Vswr (Through One Switch Only) — 5.0 at 450 MHz; 3.9 at 400 MHz; 1.9 at 250 MHz; 1.2 at 100 MHz.
Characteristic Impedance — 50 Ω ±1 Ω.
Scan Rate Variability — >10 s to <3 ms.
Make/Break Time — ≤1 ms.
Included Accessory — Instruction manual.

ORDERING INFORMATION

1360P Switch Controller **$2,590**
1360S Switch Matrix **$1,555**

TM 500 MODULAR TEST AND MEASUREMENT INSTRUMENTS



CONTENTS

Digital Counters 374
Function Generators 378
Digital Multimeters 382
Pulse Generators 385
Power Supplies 388
Audio Products 390
Signal Conditioners 392
Oscilloscopes 394
Oscilloscope Calibration Instruments 398
Mainframes 402

Manual Instruments that Perform in Hundreds of Combinations

Configurability is the watchword for TM 500 instruments and mainframes. You can create multifunction packages that encompass a wide diversity of applications. Or solve one unique application problem.

You choose from almost forty ready-to-go, compact plug-ins for a range of test and measurement needs. TM 500 Instruments include digital counters, pulse generators, function generators, amplifiers, signal processors, audio oscillators, a distortion analyzer, ramp generators, calibration instruments, power supplies, oscilloscopes, digital delay, and a digital latch. Plus three different blank plug-in kits for customizing special functions.

You put your instruments together in the mainframe that best suits your environment. There's a travel mainframe for service work and field testing; a rackmount model for production and test; or standard mainframes, compact and convenient for bench or desk, that accept one to six instruments. Rollabout carts are available for lab configurations with Tek oscilloscopes.

All TM 500 instruments and mainframes are electrically and mechanically compatible. So, through interfacing, you can configure an instrument system more powerful than the sum of its parts: an audio lab with distortion analyzer and storage scope, for example.

All of the TM 500 manual instruments may be used in TM 5000 mainframes side-by-side with the TM 5000 GPIB programmable instruments for cost effective solutions to system application where not all functions or measurements need to be programmed.

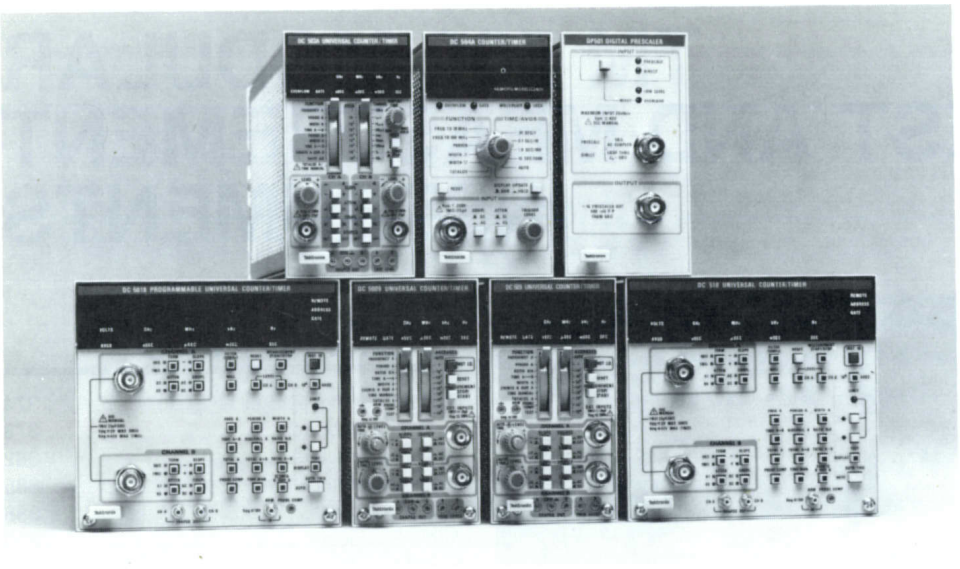
Cost efficiency is as important a part of the TM 500 concept as solving applications problems. You add on performance capabilities when you need them. And when you do add them, you can still use the same mainframe and power supply you started with.

Application and Construction Notes

The TM 500 instrument line is supported by an on-going program to keep you informed of how to achieve optimal performance and versatility from your TM 500 instruments. Tektronix' goal of providing you with solutions to difficult measurement problems does not end with your purchase of TM 500 instruments.

Application Notes take you through the steps necessary to solve complex problems, or to make more useful measurements with your TM 500 instruments. Subjects include integration through v to f conversion, generating delayed pulses, and current sinking with power supply modules.

Construction Notes provide information necessary to build custom circuits using a blank plug-in kit and standard components. These notes are developed from the actual construction of more common special circuits and include parts lists, schematics and other construction details. Some of the available TM 500 blank plug-in construction notes include: power supply circuits, thermal true RMS converter, and analog multipliers.



A Counter for Every Purpose

The TM 500 Family of digital counters provides a selection of four counters, each with its own performance and price niche, plus a prescaler which adds 1.3 GHz frequency measurement capability to the line.

The 350 MHz DC 510 and the 135 MHz DC 509 Universal Counter/Timers feature reciprocal frequency measurements and an especially wide range of other measurement functions; plus autotrigger, autoaveraging, arming, probe compensation, and more. And IEEE Standard 488 compatibility can be added as a field modification.

The DC 503A 125 MHz Universal Counter/Timer offers a wide choice of performance features, including period, width, and time-interval averaging.

The easy-to-use 100 MHz DC 504A features autorange, period and width averaging, and a 100X resolution multiplier to provide high resolution of low frequency signals.

The DP 501 Digital Prescaler adds 1.3 GHz frequency counting capability to all of the above counters except the DC 504A.

Microprocessor-Based High Performance

Both the DC 510 and DC 509 are microprocessor-based, and contain features available only in high performance, microprocessor-based instruments. Both use a powerful dual-register architecture to obtain high-resolution counting of low frequency signals. The DC 510 provides nine digits of resolution in about a third of a second; the DC 509 provides eight digits of resolution in about a second. The DC 510 provides 3.125 ns single-shot resolution for time-interval measurements. The DC 509 provides 10 ns resolution. With averaging the DC 510 can provide 1 ps resolution on time-interval measurements (the best available today); the DC 509, 5 ps resolution.

Other features available in both instruments include autotrigger, autoaveraging, probe compensation, and diagnostic self-test. At the push of a button, the autotrigger feature senses the top and bottom of the applied signal and automatically sets the trigger point midway between the two.

Autoaveraging provides the optimum combination of resolution and measurement time, regardless of the frequency of the signal. Both autotrigger and autoaveraging can be overridden to allow manual (or programmable, in the case of the GPIB versions) control of averaging, measurement time, and triggering levels.

The probe compensation feature on both instruments allows the user to quickly and accurately compensate a high-impedance probe to the instrument input impedance directly. Improperly compensated probes are a common source of timing errors when using counters without this feature.

Both instruments include an arming input and shaped outputs for added versatility when measuring selected parts of complex waveforms.

Both feature a phase-modulated time base to eliminate clock synchronous errors in all time averaging modes.

In addition to all the features of the DC 509, the DC 510 permits direct measurement and display of risetime and falltime.

The addition of the GPIB interface board (a field modification) converts both the DC 510 and DC 509 into their fully programmable, fully GPIB-compatible versions, the DC 5010 and DC 5009, respectively. See pages 360-363 for more information on these and other fully-programmable, GPIB-compatible products in the Tektronix TM 5000 product line.

Versatility in Counting, the DC 503A

The DC 503A features eight measurement functions, including period, width, and time-interval averaging. Both input channels have the full 0 MHz to 125 MHz frequency range, 20 mV RMS sensitivity, and separate controls for input coupling, attenuation, trigger level, and trigger slope. The 10 MHz clock provides 100 ns resolution of single-shot time-interval measurements, and 10 ps resolution with averaging.

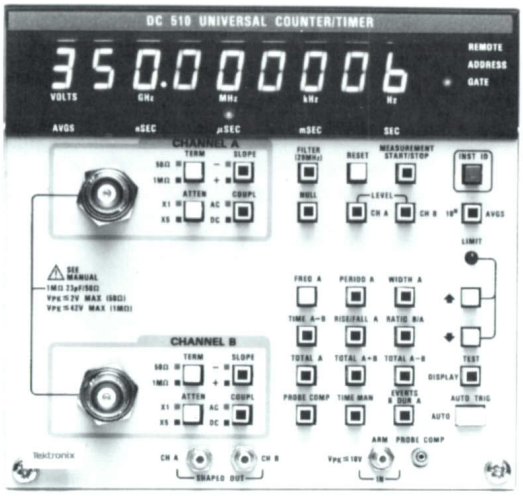
An optional accessory probe, the Tektronix P6125, has been especially designed for use with digital counters. The 5X attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. Low input capacitance permits acquisition of high-frequency signals with minimum loading of the circuits under test.

DIGITAL COUNTERS—SELECTION GUIDE

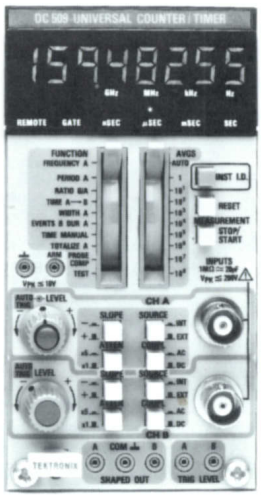
	DC 510/DC 5010	DC 509/DC 5009	DC 503A	DC 504A
Frequency Range	350 MHz	135 MHz	125 MHz	100 MHz
Number of Digits	9	8	8	6
Ratio Architecture	Yes	Yes	No	No
Period Averaging	Yes	Yes	Yes	Yes
Width Averaging (Single Input)	Yes	Yes	Yes	Yes
Time Interval Averaging	Yes	Yes	Yes	No
Autotrigger	Yes	Yes	No	No
Gated Events Averaging	B during A	B during A	A during B	No
Ratio Averaging	Yes	Yes	Yes	No
Other	Option 01, C shaped outputs self-test, phase modulated clock probe compensation 1 ps resolution 50 Ω/1 MΩ, (time A-B average) IEEE Standard 488 fully programmable (DC 5010)	Option 01, trigger level and shaped outputs, self-test, phase modulated clock, probe compensation IEEE Standard 488 fully programmable (DC 5009)	Option 01, trigger level and shaped outputs, time manual, totalize	Autorange, 100X resolution multiplier
Mainframe Compatibility	DC 510 TM 500/TM 5000 DC 5010 TM 5000 only	DC 509 TM 500/TM 5000 DC 5009 TM 5000 only	TM 500 TM 5000	TM 500 TM 5000

For compatible accessories — refer to page 421.

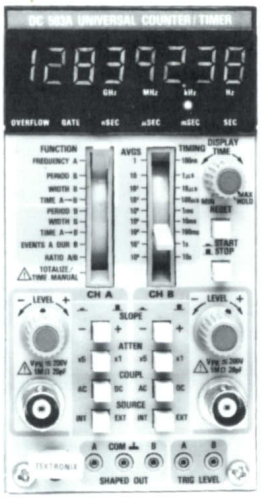
DC 510



DC 509



DC503A



Universal Counter/Timers

DC 510/DC 509

With the exception of programmability and IEEE-488 compatibility, the characteristics and specifications of the DC 510/DC 509 Universal Counter/Timers are identical to those of the DC 5010/DC 5009 Universal Counter/Timers. The detailed specifications of the DC 5010/DC 5009 Universal Counter/Timers are given on pages 360-363.

A conversion kit is available to owners of DC 510's and DC 509's who desire IEEE Standard 488 capabilities. The field modification kit easily converts a DC 510 to a DC 5010 or a DC 509 to a DC 5009.

ORDERING INFORMATION

DC 510 Universal Counter/Timer **$3,520**

DC 509 Universal Counter/Timer **$1,925**

OPTIONAL ACCESSORIES

Option 01 — High Stability Time Base ..... **+$305**

Field Option 01 Kit — For DC 510/5010 or DC 509/5009
Order 040-0966-00 ..... **$250**

Field GPIB Kits — For DC 510. Order 040-1023-03 ..... **$500**
For DC 509. Order 040-0957-03.

RECOMMENDED PROBE

P6125 5X — Passive Probe
Order 010-6125-01 ..... **$55**

DC 503A

125 MHz Both A and B Channels

Eight Measurement Functions:

- **Frequency**
- **Period and Period Average**
- **Width and Width Average**
- **Time A→B and Time A→B Average**
- **Events A During B and Events A During B Average**
- **Totalize**
- **Time Manual**
- **Ratio A/B Average**

10 ps Resolution in Time Interval Average with 10^8 Averages

Shaped Outputs for Ease of Triggering

40 MHz Rep Rate in Time Interval Average

Simplified Width Measurement

Designed for True Probe Compatibility

Trigger Level Outputs for Accurate Trigger Setting

The DC 503A offers a broad range of measurement features at an affordable price. The instrument has two input channels, A and B, each with 125 MHz capability. Each channel has separate triggering level, triggering slope, attenuator, and coupling mode controls. Eight measurement functions are available with the DC 503A and an averaging feature allows averaging of 1 to 10^8 occurrences of the signal of interest. Signals to be counted or timed can be applied to channels A and B via front panel BNC connectors, or through rear interface connections. The DC 503A features an easy access front panel and an LSI based design for increased instrument reliability.

The DC 503A can be equipped with an optional temperature controlled 10 MHz crystal oscillator (Option 01) to obtain a highly stable and precise internal time base. Both the optional oscillator and the standard 10 MHz crystal oscillator provide 100 ns resolution of single-shot time intervals.

CHARACTERISTICS

Display — Eight digit LED; indicators for units, gate open, and overflow.

Display Time — ≈0.2 s to 5 s and hold.

CHANNEL A AND B INPUT

Frequency Range — 0 MHz to 125 MHz, dc coupled. 10 Hz to 125 MHz, ac coupled.

Sensitivity — 20 mV RMS sinewave to 100 MHz, 35 mV RMS sinewave to 125 MHz. 60 mV p-p; at minimum pulse width of 5 ns to 100 MHz. 100 mV p-p at minimum pulse width of 4 ns to 125 MHz.

Impedance — 1 MΩ paralleled by ≈27 pF.

Attenuation — Selectable 1X, 5X.

Dynamic Range — V p-p ≤3 V x attenuation.
V peak ≤3.5 x attenuation.

Trigger Level — Adjustable ±3.5 V x attenuation.

Independent Controls — Slope +/−, Attenuation 1X/5X, Coupled ac/dc, Source Internal/External.

Maximum Input Voltage
1X: 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p from 1.33 MHz to 125 MHz.
5X: 200 V peak; 400 V p-p from dc to 5 MHz, derate to 20 V p-p from 100 MHz to 125 MHz.

Shaped Out — Shaped replica of signal being measured, aids proper triggering on complex waveforms. ≥200 mV p-p from 50 Ω.

Trigger Level — A dc level corresponding to the actual trigger level. Accuracy ±20 mV ±0.5% of reading.

FREQUENCY A

Range — 0 MHz to 125 MHz.

Resolution — 0.1 Hz to 10 MHz in decade steps.

Accuracy — ±1 count ± time base error x Frequency A.

PERIOD B (SINGLE SHOT)

Range — 100 ns to 10^9 s.

Resolution — 100 ns to 10 s in decade steps.

Accuracy — ±1 count ± time base error x Period B ±1.4 x CH B trigger jitter error.

Frequency Range — 0 to 125 MHz.

PERIOD B (Average)

Range — 8 ns to 10 s.

Resolution — 1 fs (10^{-15}) to 100 ns in decade steps.

Events Averaged (N) — 1 to 10^8.

Accuracy — $\pm\frac{100\text{ ns}}{N}$ ± time base error x Period B

$\pm\frac{1.4 \times \text{CH B trigger jitter error}}{N}$

Frequency Range — 0 MHz to 125 MHz.

WIDTH B (SINGLE SHOT)

Range — 100 ns to 10^9 s.

Resolution — 100 ns to 10 s in decade steps.

Accuracy —
±1 count ± time base error x Width B.
±CH B start trigger jitter error
±CH B stop trigger jitter error
+(CH B stop slew rate error—CH B start slew rate error).

NEW

WIDTH B (AVERAGE)

Range — 5 ns to 10 s.

Resolution — $\frac{100\text{ ns}}{\sqrt{N}}$

Events Averaged (N) — 1 to 10^8 in decade steps.

Accuracy —

$\pm\frac{100\text{ ns}}{\sqrt{N}} \pm$ time base error x width B.

$\pm\frac{\text{CH B start trigger jitter error}}{\sqrt{N}}$

$\pm\frac{\text{CH B stop trigger jitter error}}{\sqrt{N}}$

+(CH B stop slew rate error −CH B start slew rate error)

Frequency Range — 0 to 100 MHz.

TIME A → B (SINGLE SHOT)

Range — 100 ns to 10^9 s.

Resolution — 100 ns to 10 s in decade steps.

Accuracy —

±1 count ± time base error x Time A → B

±CH A trigger jitter error

±CH B trigger jitter error

±(CH B stop trigger slew error

−CH A start trigger slew error) ±4 ns.

TIME A → B (AVERAGE)

Range — 12.5 ns to 10 s.

Resolution — $\frac{100\text{ ns}}{\sqrt{N}}$

Minimum Dead Time — 12.5 ns (Stop-to-Start).

Events Averaged (N) — 1 to 10^8 in decade steps.

Accuracy —

$\pm\frac{100\text{ ns}}{\sqrt{N}} \pm$ time base error x Time A → B

$\pm\frac{\text{CH A trigger jitter error}}{\sqrt{N}}$

$\pm\frac{\text{CH B trigger jitter error}}{\sqrt{N}}$

+(CH B stop trigger slew error

−CH A start trigger slew error) ±4 ns

EVENTS A DURING B (AVERAGE)

Maximum A Frequency — 125 MHz.

Minimum B Pulse Width — 5 ns.

Events Averaged (N) — 1 to 10^8 in decade steps.

Accuracy —

$\pm\frac{\text{Period A}}{\text{Width B} \times \sqrt{N}}$ x Events A during B

$\pm\frac{\text{CH B start trigger jitter error}}{\sqrt{N}}$ x Frequency A (in MHz)

$\pm\frac{\text{CH B stop trigger jitter error}}{\sqrt{N}}$ x Frequency A (in MHz)

+(CH B stop trigger slew error

−CH B start trigger slew error) x Frequency A (in MHz)

RATIO A/B

Averaged over 1 to 10^8 cycles of CH B signal.

Frequency Range — 0 to 125 MHz (both CH A and CH B).

Accuracy — $\pm\frac{\text{Frequency B}}{\text{Frequency A} \times N}$

$\pm\frac{1.4 \times \text{CH B trigger jitter error} \times \text{Frequency A}}{N}$

$\pm\frac{\text{Frequency A}}{0.3 \times 10^8}$

TOTALIZE A

1 to 99,999,999 counts at maximum rate of 125 MHz. Start, stop and reset controlled by front panel pushbuttons or rear interface signal lines.

TIME MANUAL

Electronic stopwatch, accumulates and displays time between activation of front panel start/stop button or rear interface signal line. Clock rates selectable from 100 ns to 10 s in decade steps. Range 100 ns to 10^9 s.

STANDARD TIME BASE

Crystal Frequency — 10 MHz.

Temp Stability — < $\pm 5 \times 10^{-6}$, 0°C to +50°C.

Aging Rate — $<1 \times 10^{-6}$ per year.

Setability — Adjustable to within 5×10^{-8}.

OPTION 01 HIGH STABILITY TIME BASE

Crystal Frequency — 10 MHz.

Temp Stability — < $\pm 2 \times 10^{-7}$ after warm-up, 0°C to +50°C.

Warmup Time — Within 2×10^{-7} of final frequency in <10 minutes when cold started at 25°C.

Aging Rate — 1×10^{-8}/day at time of shipment, 4×10^{-8}/week after 30 days of continuous operation, 1×10^{-6}/year after 60 days of continuous operation.

Setability — Adjustable to within 2×10^{-8}.

REAR INTERFACE

Inputs — Direct count input to 50 MHz, (50 Ω impedance, resistor may be removed for 1 MΩ impedance, remote start/stop, reset; external time base.

Outputs — BCD serial-by-digit, decimal point, overflow, scan clock; trigger level; time base reference.

THE SOLUTION AND ACCURACY DEFINITIONS

Time base error is the sum of all errors specified for the time base used.

N is the number of periods averaged in Period B (AVGS) mode, the number of intervals averaged in the Time A → B (AVGS) mode, the number of widths of B averaged in Width B (AVGS) and Events A During B modes, and the number of periods of B in the Ratio A/B mode.

Trigger jitter error (in μs) = $\frac{\sqrt{(en_1)^2 + (en_2)^2\ (V)}}{\text{Input slew rate at trigger point (V/μs)}}$

Where: en_1 = 100 μV RMS typical internal noise.

en_2 = RMS noise of signal input at trigger point for a 125 MHz bandwidth.

Trigger slew rate error (in μs) = $\frac{\text{Input hysterisis (V)}/2}{\text{Input slew rate at set trigger point V/μs}}$

Where: Input hysterisis = 20 mV peak-to-peak typical.

Included Accessories — Service manual; operator's manual.

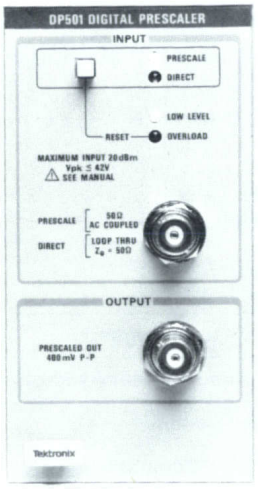
ORDERING INFORMATION

DC 503A Universal Counter/Timer **$1,095**

Option 01 — High Stability Time Base ..... **+$305**

Field Option Kit — Order 040-0966-00 ..... **+$250**

DP 501



Digital Prescaler

NEW DP 501

Extends Frequency Measurement Capability to 1.3 GHz

Compatible with Most TM 500 and TM 5000 Counters

AGC

Low Level Indicator

The DP 501 Digital Prescaler adds 1.3 GHz frequency counting capability to the Tektronix DC 503A, DC 509, DC 5009, DC 510, and DC 5010 Universal Counter/Timers.

In use, the DP 501 is placed in the signal line between the signal source and the counter's input connector such that the signal to be measured passes through the DP 501. Two operating modes are available, Prescale and Direct. In the Prescale mode, the DP 501 divides the input signal by 16 and causes the associated counter's display to be multiplied by 16, so that the counter will display the correct frequency. In the Direct mode, the signal is simply looped through the DP 501 and applied directly to the counter's input; the counter's display is not affected. This loop-through capability eliminates the need for external switching when input signal frequencies occur in both the Prescale and Direct frequency ranges.

The prescaling function can be activated in either of two ways: manually, with a front-panel push button; or, when used with the GPIB programmable DC 5009 or DC 5010, by a Prescale command to the counter. Thus, the DP 501 adds programmable frequency measurements to 1.3 GHz to the Tektronix TM 5000 Family of GPIB programmable instruments.

Input sensitivity in the Prescale mode is 20 mV RMS to 1 GHz and 30 mV RMS to 1.3 GHz. A Low-Level indicator alerts the user if the input signal amplitude is too low for error-free counting. An automatic gain control circuit provides optimum immunity to signal noise in the Prescale mode.

The DP 501 and DC 509 or DC 510 can be used with the Tektronix 7L14 Spectrum Analyzer and TR 502 Tracking Generator to provide counter accuracy measurements of swept-frequency signals from 100 kHz to 1.3 GHz.

CHARACTERISTICS

Prescale Mode

Input: Frequency range is ≤100 MHz to ≥1.3 GHz.
Sensitivity: 100 MHz to 1 GHz is ≤20 mV RMS (−21 dBm).
1 GHz to 1.3 GHz is ≤30 mV RMS (−17 dBm).
Impedance: 50 Ω, ac coupled; vswr ≤2.2:1.
Output: Amplitude into 50 Ω is ≥200 mV, p-p. Unterminated is 2X terminated value.

Direct Mode

Input: Connected directly to output.
Frequency Range: 0 to >350 MHz.
Impedance: Loop through characteristic impedance is 50 Ω; nonterminated capacitance ≈20 pF (no connection to output).
Output: Connected directly to input. <1 dB insertion loss up to 350 MHz. Powers up in direct mode.

Overload Protection

Prescale: Input disconnects when input signal exceeds +20 dBm ±5 dBm for a period of ≈0.5 s or more.

Damage Level

Prescale: Input may be damaged if signal level exceeds +25 dBm.
Direct: 42 V peak maximum. Maximum current is 250 mA.

Input Attenuation

Automatic: Up to 40 dB range.

Low Level Indicator — Lights when input signal is below that required for error-free counting.

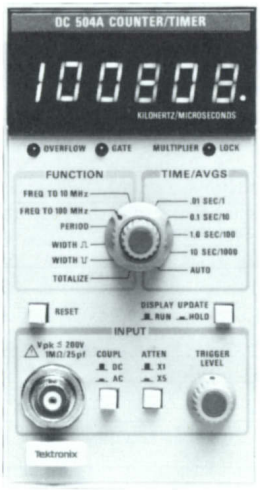
Tracking Generator Compatibility — Outputs will drive two standard TTL loads. Inputs represent two standard TTL loads. Requires arming input to associated counter.

Included Accessory — Instruction manual.

Order DP 501 Digital Prescaler **$500**

NEW

DC 504A



Counter/Timer

NEW DC 504A

Dc to 100 MHz

Period and Period Averaging

Width and Width Averaging

Autoranging

100X Resolution Multiplier

The easy-to-use DC 504A Counter/Timer measures frequency from dc to 100 MHz, with an internal prescaler being used for frequencies above 10 MHz. Both direct and prescaled counting are done through the same input connector; no need to change connectors when changing frequency range. Autoranging permits virtual hands-off operation for most measurements. The 100X resolution multiplier automatically provides 0.01 Hz resolution in one second—or 0.001 Hz resolution in ten seconds—on signals from 10 Hz to 25 kHz.

The DC 504A features period and width averaging of up to 1000 events. Selectable dc coupling of the input eliminates the potential errors associated with making width measurements on signals of varying duty cycle with counters that are only ac coupled. Input trigger sensitivity is 30 mV RMS across the entire 100 MHz frequency range. The triggering level range of ±2 volts and the selectable 5X attenuator provides a triggering range of up to ±10 volts.

The totalize mode permits totalizing up to 999,999 events—and beyond, with overflow—with a Display Update-Run/Hold control to hold the display while the internal counter continues to advance.

CHARACTERISTICS

Display — Six-digit LED readout with automatic decimal point positioning and leading zero suppression. LED annunciators indicate gate open, resolution multiplier lock, and display overflow.

INPUT CHARACTERISTICS

Input Frequency Range
Front Panel: Dc Coupled: 1 MHz to 100 MHz. Ac Coupled: 10 Hz to 100 MHz.
Rear Interface: Dc Coupled: 0 MHz to 50 MHz. Ac Coupled: 10 Hz to 50 MHz.

Input Sensitivity
1X Attenuation: 30 mV RMS sinewave (85 mV p-p) to 100 MHz; 85 mV p-p pulse at a minimum width of 5 ns.
5X Attenuation Accuracy: Within 2% at dc.

Input Dynamic Range
1X: ±2.0 V peak, 4 V p-p.
5X: ±10 V peak, 20 V p-p.

Trigger Level Range — ±2.0 V x attenuation, minimum.

Maximum Safe Input Voltage
Front Panel:
1X: 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p from 1.33 MHz to 100 MHz.
5X: 200 V peak; 400 V p-p from dc to 50 MHz, derate to 20 V p-p at 100 MHz.
Rear Interface: ≤4 V peak.

Input Impedance
Front Panel: 1X, 5X: 1 MΩ, paralleled by ≈25 pF.
Rear Interface: 1X, 5X: 50 Ω ±10% at dc.

FREQUENCY TO 10 MHz

Range — Dc Coupled: 0 Hz to 10 MHz. Ac Coupled: 10 Hz to 10 MHz.

Accuracy — ±1 count ±time base error x frequency.

Gate Time — 10 ms to 10 s, selectable in decade steps; or autoranging (10 ms to 1 s only).

Resolution
Multiplier Off: 100 Hz to 0.1 Hz, selectable in decade steps; or autoranging (100 Hz to 1 Hz only).
Multiplier On: 1 Hz to 0.001 Hz, selectable in decade steps; or autoranging (1 Hz to 0.01 Hz only).
Lock Range: 10 Hz ≤Frequency ≤25 kHz.
Multiplication: 100X.
Lock Time: ≤5 s.

Resolution multiplier automatically increases resolution by 100 when locked; may be defeated by an internal jumper.

FREQUENCY TO 100 MHz

Range — Dc Coupled: 0 Hz to 100 MHz. Ac Coupled: 10 Hz to 100 MHz.

Prescale Factor — ÷10.

Accuracy — ±1 count ±time base error x frequency.

Gate Time (Resolution) — 10 ms to 10 s (1 kHz to 1 Hz), selectable in decade steps; or autoranging (10 ms to 1 s only).

PERIOD AVG

Frequency Range — Dc Coupled: 0 Hz to 2.5 MHz. Ac Coupled: 10 Hz to 2.5 MHz.

Events Averaged (N) — 10^0 to 10^3, selectable in decade steps; or autoranging (10^0 to 10^2 only).

Resolution — 100 ns to 100 ps, selectable in decade steps; or autoranging (100 ns to 1 ns only).

Accuracy —

$$\pm\frac{100\text{ ns}}{N} \pm \text{ time base error x period.}$$

$$\pm 1.4 \text{ X } \left(\frac{\text{trigger jitter error}}{N}\right)$$

WIDTH AVG

Frequency Range — Dc Coupled: 0 Hz to 2.5 MHz. Ac Coupled: 10 Hz to 2.5 MHz.

Events Averaged (N) — 10^0 to 10^3, selectable in decade steps; or autoranging (10^0 to 10^2 only).

Resolution — $\pm\frac{100\text{ ns}}{\sqrt{N}}$

Accuracy —

$$\pm\frac{100\text{ ns}}{\sqrt{N}} \pm \text{ time base error x width.}$$

$$\pm\frac{\text{start trigger jitter error}}{\sqrt{N}}$$

$$\pm\frac{\text{stop trigger jitter error}}{\sqrt{N}}$$

+(stop slew rate error - start slew rate error)

±10 ns

TOTALIZE

Frequency Range — Dc Coupled: 0 Hz to 10 MHz. Ac Coupled: 10 Hz to 10 MHz. Overflows above 999,999. Display update Run/Hold will hold display while counter continues to advance. Releasing Run/Hold will update display to new value.

RESOLUTION AND ACCURACY DEFINITIONS

Same as DC 503A except DC 504A has 100 MHz bandwidth and input hysteresis = 30 mV p-p typical.

TIME BASE

Time Base
Frequency (At Calibration): 10 MHz ±1 x 10^{-7}.
Adjustment Resolution: ±5 x 10^{-8}.
Temperature Stability (0°C to +50°C): ±5 x 10^{-6} (±5 ppm).
Aging: ≤1 x 10^{-6}/year (≤1 ppm/year).
External Time Base Input — 10 MHz.
Must drive 1 LSTTL load.
V_{IH} = 2.0 V/20 μA
V_{IL} = 0.8 V/−400 μA
Included Accessory — Instruction manual.

Order DC 504A Counter/Timer **$710**

OPTIONAL COUNTER ACCESSORIES

P6101 X1 Probe — Dc to 34 MHz.
Order 010-6101-03 ..... **$67**

P6106 X10 Probe — Dc to 300 MHz.
Order 010-6106-03 ..... **$135**

P6201 FET Probe — Dc to 900 MHz.
Order 010-6201-01 ..... **$1,145**

P6056 50 Ω, X10 Probe — Dc to 3.5 GHz.
Order 010-6056-03 ..... **$165**

Power Divider — GR, 50 Ω.
Order 017-0082-00 ..... **$350**

Adaptor — GR to BNC female.
Order 017-0067-00 ..... **$55**

Adaptor — GR to BNC male.
Order 017-0064-00 ..... **$75**

Cable Adaptor — BNC to tipjack (DC 503A, DC 509. DC 5009).
Order 175-3765-01 ..... **$23**

Cable Adapator — BNC to RF (DC 510, DC 5010).
Order 012-0532-00 ..... **$38**

P6125 Counter Probe

The P6125 is a low-capacitance, 5X attenuation passive probe specially designed for use with counter/timers. It makes possible more accurate time interval measurements of high speed logic signals. Five-times attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. The low input capacitance permits acquisition of high frequency signals with minimum loading of the circuits under test.

Attenuation — 5X.
Input Resistance — 5 MΩ input.
Capacitance — ≈20 pF.
Bandwidth — Dc to 200 MHz.
Voltage Rating — 250 V (dc + peak ac) derated to 35 V at 100 MHz.
Cable Length — 1.5 meters.

INCLUDED ACCESSORIES

8 cm ground lead (175-0263-01); 2 miniature alligator clips (344-0046-00); accessory pouch (016-0521-00); IC tip tester*1, two 13 cm ground lead probe*2 tips (175-0124-01); retractable hook tip (013-0107-03); probe holder (352-0351-00); insulating sleeve (166-0401-01); instruction manual.

*1 Available in pkgs of 10 (015-0201-04) or 100 (015-0201-05).
*2 Available in pkgs of 10 only (206-0191-03).

P6125 Counter Probe, 5X, 1.5 m
Order 010-6125-01 ..... **$55**

When your test and measurement problems require more waveforms for more applications, the high performance TM 500 Function Generators are a versatile solution singly or in combination with one another.

For applications demanding logarithmic or linear sweep the FG 507 offers an accurate and versatile solution. The low distortion, combined with log and linear sweep, is particularly useful in audio and linear communications-oriented applications.

For low-frequency function generator applications, set the FG 501A, FG 502, FG 503, or FG 507 to work on biological, geophysical and mechanical simulations or on servo systems.

Applying an external ramp to the VCF input allows any of the TM 500 function generators to double as sweep generators. Applying a suitable modulating signal can produce a frequency-modulated carrier. In addition, the FG 504 and FG 507 can supply internally generated linear or logarithmic sweeps with convenient two-dial control of start and stop frequencies.

Sweeping wide frequency ranges (up to 1000:1) with logarithmic sweep allows you to spread out lower octaves, sweep a full range in less time, and produce easy-to-read Bode plots and graphs.

You can control the starting phase of a waveform in the gated burst or triggered mode with the FG 501A, FG 504, FG 507 and the FG 5010. A gated or triggered waveform efficiently tests tone-controlled systems, loud speaker transient response characteristics, automatic gain control circuits, or other amplitude sensitive systems.

The FG 504's phase lock mode feature lets you convert digital signals to high or low voltage sinewaves, pulses, or triangles; ideal for locking the function generator's output to a house or system frequency standard. With the DD 501 Digital Delay Generator in the "divide by n" mode, the FG 504 can be locked to your frequency reference at a lower frequency.

FUNCTION GENERATORS

	FG 501A	FG 507
Waveforms	Sine, Square, Triangle, Pulse and Ramp with variable symmetry	
Symmetry	≤5% to ≥95% Variable	≤5% to >95% Variable
Frequency Range	0.002 Hz to 2 MHz 200 kHz ±10% with variable symmetry on	0.002 Hz to 2 MHz 200 kHz ±10% with variable symmetry on
Dial Accuracy (% of Full Scale) (except FG 5010)	Within 3%	Within 3% Within 5% in sweep mode*2
Custom Frequency Range	No	No
Frequency Stability (% of Full Scale)	≤0.05% for 10 min., ≤0.1% for 1 hour, ≤0.5% for 24 hours, constant temperature	
Amplitude: Open Circuit	30 V p-p	30 V p-p
Into 50 Ω	15 V p-p	15 V p-p
Attenuator	0 to −60 dB in 20 dB Steps >20 dB additional with AMPL control	
Offset: Open Circuit	±13 V dc, step attenuator decreases offset	
Into 50 Ω	±6.5 V dc, step attenuator decreases offset	
Pk Sig + Offset: Open Circuit	±15 V	±15 V
Into 50 Ω	±7.5 V	±7.5 V
Output Impedance	50 Ω	50 Ω
Amplitude Flatness (10 kHz ref, 50 Ω load) Sine-wave	±0.1 dB 20 Hz to 20 kHz ±0.5 dB 20 kHz to 1 MHz ±1 dB 1 MHz to 2 MHz	±0.1 dB 20 Hz to 20 kHz ±0.5 dB 20 kHz to 1 MHz ±1 dB 1 MHz to 2 MHz
Triangle	±0.5 dB 20 Hz to 200 kHz ±2 dB 200 kHz to 2 MHz	±0.5 dB 20 Hz to 200 kHz ±2 dB 200 kHz to 2 MHz
Square-wave	±0.5 dB 20 Hz to 2 MHz	±0.5 dB 20 Hz to 2 MHz
Sinewave Distortion (Maximum Output, 50 Ω load)	≤0.25% 20 Hz to 20 kHz*2 ≤0.5% 20 kHz to 100 kHz Harmonics: ≤−30dB, 100 kHz to 2 MHz	≤0.25% 20 Hz to 20 kHz*2 ≤0.5% 20 kHz to 100 kHz Harmonics: ≤−30 dB, 100 kHz to 2 MHz
Squarewave Response	≤25 ns rise/fall <3% p-p aberrations	≤25 ns rise/fall <3% p-p aberrations
Triangle Linearity (10% to 90%)	≥99% 20 Hz to 200 kHz ≥97% 200 kHz to 2 MHz	≥99% 20 Hz to 200 kHz ≥97% 200 kHz to 2 MHz
Trigger Output	≥+4 V from 50 Ω	≥+4 V from 50 Ω
External Input	Impedance ≈2 kΩ Trigger threshold level +1 V ±20%	Impedance ≈2 kΩ Trigger threshold level +1 V ±20%
Trigger	±90° variable start phase control	±90° variable start phase control
Gate	±90° variable start phase control	±90° variable start phase control
Phase Lock	No	No
Counted Burst	With DD 501	With DD 501
Internal Sweep	No	Logarithmic or Linear, Separate Start/Stop Dials
Duration		1 ms to 100 s
External Trigger		±1 V ±20 % trigger level ≈2 kΩ input impedance
Ramp Output	NA	≤0.3 V to 10 V from 1 kΩ ±5%
Gate Output		≥+4 V from 50 Ω
Other Modes		Manual Sweep Trig Manual Sweep Sweep and Hold
Amplitude Modulation	No	No
Voltage Controlled Frequency (FM)	Up to 1000; 1 Frequency change with 10 V external signal Slew rate ≥0.3 V/μs, 10 kΩ input impedance	
Nominal Hz/Volt Sensitivity	2 x Frequency Multiplier setting	2 x Frequency Multiplier
Output Hold Mode	No	No
Temperature*4	0°C +50°C Operating, −55°C to +75°C Nonoperating	

*1 +15° C to +35° C ambient

*2 +20° C to +30° C ambient

*3 20 Hz to 20 kHz modulation frequency

*4 FG 504 requires forced air circulation above +40° C

*5 Fully programmable, see page 365 for complete information.

*6 IEEE Standard 488 Compatible

*7 Percent of indicated frequency

*8 Absolute voltage accuracy

*9 Separate FM function provided (1%/V)

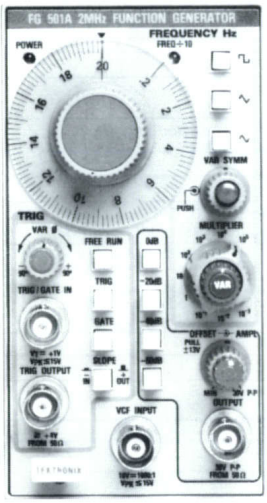
Compatible accessories begin on page 458.

COMPARISON OF CHARACTERISTICS

	FG 504	FG 502	FG 503	FG 5010*5*6
Waveforms	Sine, Square, Triangle, Pulse and Ramp with variable symmetry	Sine, Square, Triangle Pulse, or Ramp	Sine, Square, Triangle	Sine, Square, Triangle, Pulse and Ramp with variable symmetry
Symmetry	7% to 93% Variable	5%, 50%, 95% Fixed	50% Fixed	10% to 90%, 1% steps
Frequency Range	0.001 Hz to 40 MHz 4 MHz nominal with variable symmetry on	0.1 Hz to 11 MHz Pulse and Ramp, 1.1 MHz	1.0 Hz to 3 MHz Usable 0.01 Hz to 5 MHz	0.002 Hz to 20 MHz
Dial Accuracy (% of Full Scale) (except FG 5010)	Within 3% to 4 MHz*1 Within 6% to 40 MHz*1	Within 3% to 1 MHz Within 5% to 10 MHz	Within 5%	Within 0.1% of selected frequency Digital LED Display
Custom Frequency Range	Shipped with capacitor for 20 Hz to 20 kHz	No	With user-installed capacitor	NA
Frequency Stability (% of Full Scale)	≤0.05% for 10 minutes, ≤0.1% for 1 hour, ≤0.5% for 24 hours, constant temperature			≤0.05% for 1 hr, 0.05% for 24 hrs (≤0.1% in trigger, gate, burst mode <200 Hz)*7
Amplitude: Open Circuit	30 V p-p	10 V p-p	20 V p-p	20 V p-p
Into 50 Ω	15 V p-p	5 V p-p	10 V p-p	10 V p-p
Attenuator	0 to −50 dB in 10 dB steps <10 mV p-p with VAR control	Variable control only	Variable control only	Digital Control of fixed and variable 10 mV p-p into 50 Ω
Offset: Open Circuit	±7.5 V dc	±5 V dc	±7.5 V dc	±7.5 V dc
Into 50 Ω	±3.75 V dc	±2.5 V dc	±3.75 V dc	±3.75 V dc
Pk Sig + Offset: Open Circuit	±20 V	±10 V	±15 V	±15 V
Into 50 Ω	±11.25 V	±5 V	±6 V	±7.5 V
Output Impedance	50 Ω	50 Ω	50 Ω	50 Ω
Amplitude Flatness (10 kHz ref, 50 Ω load) Sine-wave	±0.5 dB 0.001 Hz to 40 kHz	±0.5 dB 20 Hz to 20 kHz ±1.5 dB 0.1 Hz to 11 MHz	±0.5 dB 20 Hz to 20 kHz ±2 dB 0.1 Hz to 3 MHz	±3% from 0.002 Hz to 1 kHz ±3.5% from 1 kHz to 1 MHz ±5% from 1 MHz to 5 MHz +5%, −10% from 5 MHz to20 MHz
Triangle	±2 dB 40 kHz to 40 MHz	±3 dB referenced to Sinewave	±1 dB referenced to Sinewave	±2% from 0.002 Hz to 1 kHz ±3.5% from 1 kHz to 100 kHz ±4% from 100 kHz to 1 MHz +4%, −5% from 1 MHz to 5 MHz +4%, −20% from 5 MHz to 20 MHz
Square-wave	±0.5 dB to 20 MHz ±2 dB to 40 MHz			±2% from 0.002 Hz to 1 kHz ±3.5% from 1 kHz to 1 MHz ±5% from 1 MHz to 10 MHz ±10% from 10 MHz to 20 MHz
Sinewave Distortion (Maximum output, 50 Ω load)	≤0.5% 20 Hz to 40 kHz*1 Harmonics: ≤−30 dB 40 kHz to 1 MHz <−20 dB 1 MHz to 40 MHz	≤0.5% 10 Hz to 50 kHz*2 Harmonics: ≤−30 dB at all other frequencies	≤0.5% 1 Hz to 30 kHz ≤1.0% 30 kHz to 300 kHz ≤2.5% 300 kHz to 3 MHz	≤0.5% 20 Hz to 19.99 kHz*1 ≤1.0% 20 kHz to 99.99 kHz Harmonics >30 dB down, 100 kHz to 20 MHz
Squarewave Response	≤6 ns rise/fall fixed 10 ns to 100 ms variable ≤5% p-p +30 mV aberrations	≤20 ns rise/fall ≤3% p-p aberrations	≤60 ns rise/fall ≤3 p-p aberrations	≤10 ns rise/fall ≤5% p-p aberrations
Triangle Linearity (10% to 90%)	≥99% 10 Hz to 400 kHz ≥95% 400 kHz to 40 MHz type ≥98% 0.001 Hz to 10 Hz	≥99% 0.1 Hz to 100 kHz ≥97% 100 kHz to 1 MHz ≥95% 1 MHz to 11 MHz	≥99% 1 Hz to 100 kHz ≥95% 100 kHz to 3 MHz	>98% to 2 MHz >90% to 20 MHz
Trigger Output	≥+2 V from 50 Ω	+2.5 V to 50 Ω load	+2.5 V to 600 Ω load	+2 V from 50 Ω
External Input	Impedance ≥10 kΩ Sensitivity ≤1 V p-p Trigger level −1 V to +10 V	Impedance ≈1 kΩ ≥+2 V Gate Signal required	No	1 MΩ/50 Ω internal setability 0.0 V/0.5 V internal setability
Trigger	20 MHz maximum ±80° start phase control to 10 MHz	No	No	±90° variable start phase control
Gate		Fixed 0° start phase	No	±90° variable start phase control
Phase Lock	100 Hz to 40 MHz ±80° phase range	No	No	20 Hz to 20 MHz (Auto Scan)
Counted Burst	With DD 501	With DD 501	No	1 to 9999
Internal Sweep	Logarithmic or Linear, Separate Start/Stop Dials	No	No	No
Duration	0.1 ms to 100 s	NA	NA	NA
External Trigger	+1 V to +10 V trigger level 1 V p-p sensitivity			
Ramp Output	0 to +10 V from 1 kΩ ±5% to 1 ms, ±10% ≤1 ms			
Gate Output	No			
Other Modes	Manual Sweep Trig			
Amplitude Modulation	100% with nominal 5 V p-p input Dc to 100 kHz modulation frequency <5% distortion to 4 MHz at 70%*3 <10% distortion to 40 MHz at 65%*3	No	No	100% with nominal 5 V p-p input Dc to 100 kHz modulation frequency <2% distortion to 2 MHz at 70% <4% distortion to 20 MHz at 70%
Voltage Controlled Frequency (FM)	Up to 1000: 1 Frequency change with 10 V external signal Slew rate ≥0.3 V/ms, 10 kΩ input impedance			Up to 1000: 1 frequency*9 change with 10 V external input
Nominal Hz/Volt Sensitivity	4 x Frequency Multiplier	1.1 x Frequency Multiplier	3 x Frequency Multiplier	10% of selected range
Output Hold Mode	0.001 Hz to 400 Hz	No	No	0.002 Hz to 200 Hz
Temperature*4	0°C to +50°C Operating, −55°C to +75°C Nonoperating			

Compatible accessories begin on page 458.

FG 501A



2 MHz Function Generator

FG 501A

0.002 Hz to 2 MHz

30 V Peak-to-Peak, ±13 V Offset

5% to 95% Variable Symmetry

Trigger or Gate, ± Slope

60 dB Step Attenuator

I0.25% Sinewave Distortion

I25 ns Rise/Fall

The FG 501A provides low-distortion outputs from 0.002 Hz to 2 MHz. It is capable of generating five basic waveforms—sinewave, squarewave, triangle, ramp, and pulse—at output levels up to 30 V peak-to-peak with up to ±13 V of offset from a 50 Ω source. Waveform triggering and gating are provided with a variable phase control to permit up to ±90° of phase shift for generating haversines, $\sin^2$ pulses, and haver triangles. A step attenuator provides 60 dB of output signal attenuation in 20 dB steps with an additional 20 dB of variable attenuation. Variable symmetry from 5% to 95% provides ramps and pulses. Pulse risetime is ≤25 ns. Audio sinewave distortion is ≤0.25% and audio amplitude flatness is within 0.1 dB.

Because of its ability to generate low distortion sinewaves, the FG 501A is uniquely appropriate for applications demanding audio signals.

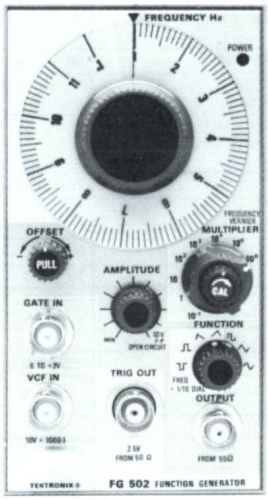
Also useful in audio applications is the 0 dB to 60 dB attenuator designed into the FG 501A.

The wide range variable symmetry of the FG 501A is useful for generation of pulses and ramps.

Included Accessory — Instruction manual.

Order FG 501A 2 MHz
Function Generator **$785**

FG 502



11 MHz Function Generator

FG 502

0.1 Hz to 11 MHz

Five Waveforms

VCF and Gated Burst

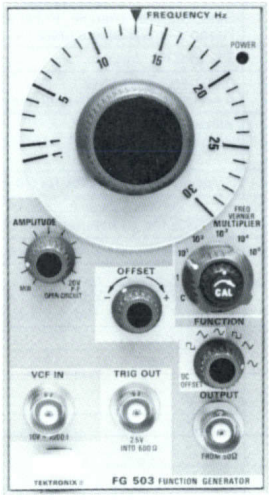
The FG 502 Function Generator provides low-distortion sine, square, and triangle waveforms, and positive or negative ramps and pulses. Output frequency is continuously variable from 0.1 Hz to 11 MHz. The high frequency range from 1 MHz to 11 MHz permits the versatility of the function generator to be extended into the medium radio frequency range. VCF input permits the FG 502 to be used as a sweep generator or as an FM generator.

The external gate input permits the FG 502 output in any of its modes to be controlled by an externally supplied pulse to generate bursts of various output waveforms. This feature has application in wireless or radio remote control equipment and in certain phases of the telephone industry.

Included Accessory — Instruction manual.

Order FG 502 11 MHz
Function Generator **$920**

FG 503



3 MHz Function Generator

FG 503

1.0 Hz to 3 MHz

Three Waveforms

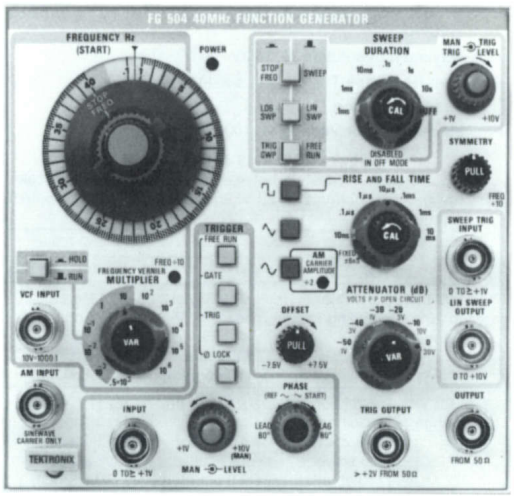
VCF

The FG 503 Function Generator provides high-quality low-distortion sine, square, and triangle waveforms. Six decade frequency multipler steps, a custom position for user-determined frequency multiplication, a dial calibrated from 1.0 to 30 (uncalibrated from 0.1 to 1.0), and a frequency vernier control work together to select frequencies in overlapping ranges from 1 Hz to 3 MHz. The output frequency may be swept over a 1000:1 ratio by an external voltage. Output amplitude and offset controls are provided. A trigger output is available for controlling external devices or equipment. Amplitude up to 10 V peak-to-peak can be developed across a 50 Ω load (20 V peak-to-peak open circuit). Selectable offset up to 3.75 V dc across 50 Ω (7.5 V dc open circuit) is also featured.

Included Accessory — Instruction manual.

Order FG 503 3 MHz
Function Generator **$580**

FG 504



40 MHz Function Generator

FG 504

0.001 Hz to 40 MHz

Three Basic Waveforms, Plus a Wide Range of Shaping with Variable Risetimes and Falltimes and Symmetry Controls

Logarithmic or Linear Sweep

Up to 30 V P-P Output

Built-In Attenuator

AM and FM

Phase Lock Mode

External and Manual Trigger or Gate

Counted Burst with DD 501

The output of the FG 504 may be phase locked, gated, or triggered by a reference signal, letting you convert from one waveform to another, such as pulses to sinewaves, as well as adjust phase relationships. Post attenuator offset enables use of the full ±7.5 V offset range with small signals. And the FG 504 output can be swept, or amplitude or frequency modulated by external signals. In addition, the FG 504 can supply internally generated linear or logarithmic swept frequencies of up to 1000:1 range with convenient control of start and stop frequencies.

The FG 504 also provides trigger output, external voltage control input, and sweep output.

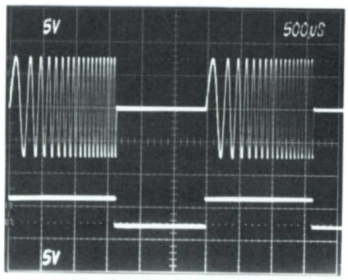
Included Accessory — Instruction manual.

ORDERING INFORMATION

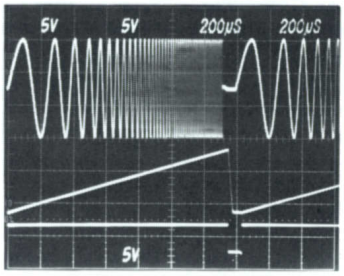
FG 504 40 MHz Function Generator .. **$2,730**

FG 504T 40 MHz Function Generator **$3,095**

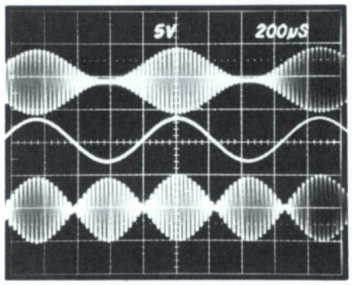
(Includes FG 504, TM 503 Mainframe, and 016-0195-03 Blank Panel.)



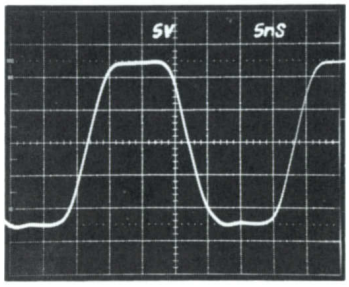
FG 507 triggered sweep mode with output gated on by sweep gate.



FG 507 in logarithmic sweep with sweep ramp and gate outputs.

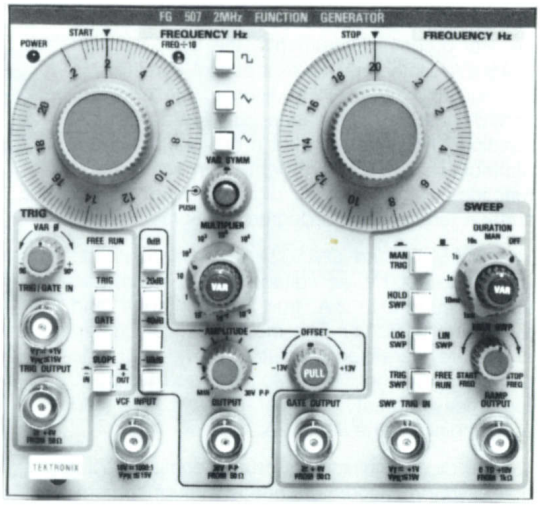


True four quadrant multiplier permits normal am or double sideband suppressed carrier modulation.



FG 504 30 volt output with 6 ns risetime and falltime for superior pulse waveforms.

FG 507



2 MHz Sweeping Function Generator

FG 507

0.002 Hz to 2 MHz

Includes All FG 501A Features

Logarithmic or Linear Sweep

Separate Start/Stop Frequency Dials

Sweep Up or Down

Sweep and Hold

Manual Sweep

The FG 507 features the same basic performance as the FG 501A and adds flexible, easy-to-use log and linear sweep capability.

The log sweep of the FG 507 is mathematically correct and allows accurate frequency plots when using log scales, log paper, or a storage oscilloscope like the SC 503. Separate start and stop frequency dials make frequency settings easy to adjust and interpret. The instrument can be internally or externally swept up or down. A third frequency control allows you to manually sweep between the preset start and stop frequencies without disturbing their settings. This is especially convenient for examining frequency and amplitude anomalies of a circuit under test or in setting start and stop points. The sweep generator can be swept and the sweep gate output can be used to gate (burst) the generator on for swept bursts. The sweep hold mode allows the generator to sweep to the stop frequency and remain there until released.

The accurate log/linear sweep capability of the FG 507 plus the low distortion (0.25% over the audio range) make it ideally suited to audio testing.

Included Accessory — Instruction manual.

Order FG 507 2 MHz Sweeping Function Generator **$1,435**

PRODUCT SUMMARY

The TM 500 Digital Multimeter line consists of two general purpose instruments, the DM 501A and DM 502A. Both provide exceptional versatility in function and range. In addition to the usual ac and dc voltage, resistance, and ac/dc current functions, both meters offer a dB function and a platinum-resistance temperature-measurement function, which provides digital readout of the surface temperature in degree Centigrade.

The DM 501A and DM 502A each measure dc voltage to 1000 V, ac voltage to 500 V, both ac and dc current to 2 A, true RMS voltages, and resistance to 20 MΩ. The most significant differences are increased resolution provided by the extra digit on the DM 501A, increased temperature measurement range of the DM 501A and autoranging on the DM 502A.

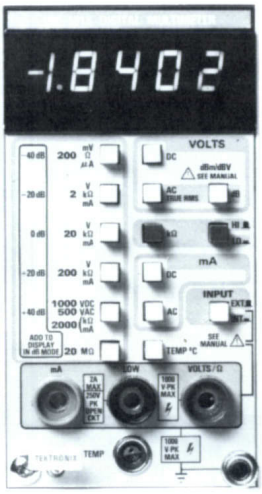
TM 500 digital multimeters offer a compact solution to your measurement needs without compromising wide performance range. The DM 501A and DM 502A provide accuracy and flexibility in laboratory bench, field service, and maintenance applications.

DIGITAL MULTIMETER SELECTION GUIDE

Model Number	DM 501A	DM 502A	DM 5010
Number of Digits	4½	3½	3½/4½*1
Dc Volts Ranges	200 mV to 1000 V	200 mV to 1000 V	200 mV to 1000 V
Dc Volts Accuracy	±0.05%	±0.1%	±0.015%
Dc Volts Best Resolution	10 μV	100 μV	10 μV
Ac Volts Ranges	200 mV to 500 V	200 mV to 500 V	200 mV to 700 V
Ac Volts Accuracy	±0.6%	±0.6%	±0.2%
Ac Volts Best Resolution	10 μV	100 μV	10 μV
Ac or Dc Current Ranges	200 μA to 2 A	200 μA to 2 A	N/A
dB Ranges	+54 dB to −60 dB	+50 dB to −60 dB	Calculated
Resistance (HI-LO) Ranges	200 Ω to 20 MΩ	200 Ω to 20 MΩ	200 Ω*2 to 20 MΩ
Temperature Range	−62°C to +240°C	−55°C to +200°C	N/A
True RMS	Yes	Yes	Yes
Auto Range	Yes	No	Yes
IEEE Standard 488	No	No	Yes*3
Mainframe Compatibility	TM 500 TM 5000	TM 500 TM 5000	TM 5000

*1 *Measurement rate of 3 readings/s at 4.5 digits, and 26 readings/s at 3.5 digits resolution.*
*2 *Low Ω plus diode test.*
*3 *Fully programmable, IEEE-488 compatible.* *See page 364 for complete description.*

DM 501A



Digital Multimeter

DM 501A

0.05% dc Voltage Accuracy

7 Functions Including Temperature and dB

4½ Digits of Readout Resolution

True RMS Capability

The DM 501A Digital Multimeter measures dc and ac voltage, dc and ac current, resistance, dB and temperature. The DM 501A gives 4½ digits of readout resolution. All with 0.05% accuracy and true RMS capability. True RMS allows accurate measurement of distorted waveforms. DB is useful when making critical audio and communication measurements. Fast accurate temperature measurements to 240°C come from the Tektronix P6601 platinum film temperature sensing probe. The P6601 reaches 90% of final reading in 1.5 seconds.

CHARACTERISTICS

DC VOLTS

Ranges — 200 mV, 2 V, 20 V, 200 V, and 1000 V.

Accuracy*1

+18°C to +28°C	
200 mV Range	±[0.05% of reading +0.015% of full scale (3 counts)]
2 V to 200 V Ranges	±[0.05% of reading +0.01% of full scale (2 counts)]
1000 V Range	±[0.05% of reading +0.02% of full scale (2 counts)]
0°C to +18°C and +28°C to +50°C	
200 mV to 200 V Ranges	±[0.1% of reading +0.025 of full scale (5 counts)]
1000 V Range	±[0.1% of reading ±0.05% of full scale (5 counts)]

*1 *Valid for a period of six months or 1000 hours, whichever occurs first.*

Common-Mode Rejection Ratio — ≥100 dB at dc. ≥80 dB at 50 Hz and 80 Hz with 1 kΩ imbalance.

Normal-Mode Rejection Ratio — ≥60 dB at 50 Hz or 60 Hz ±0.2 Hz.

Maximum Resolution — 10 μV.

Step Response Time — <1 second.

Input Resistance — 10 MΩ.

Maximum Input Voltage — 1000 V peak.

TRUE RMS AC VOLTS

Input Signal — Must be between 5% and 100% of full scale.

Ranges — 200 mV, 2 V, 20 V, 200 V, and 500 V (ac coupled).

Accuracy*1

+18°C to +28°C			
20 Hz	40 Hz	10 kHz	20 kHz
200 mV to 200 V Ranges	±[1% of reading +0.05% of full scale (10 counts)]	±[0.6% of reading +0.05% of full scale (10 counts)]	±[1% of reading +0.05% of full scale (10 counts)]
500 V Range	±[1% of reading +0.2% of full scale (10 counts)]	±[0.6% of reading +0.2% of full scale (10 counts)]	±[1% of reading +0.2% of full scale (10 counts)]
0°C to +18°C and +28°C to +50°C			
20 Hz	40 Hz	10 kHz	20 kHz
200 mV to 200 V Ranges	±[1.3% of reading +0.075% of full scale (15 counts)]	±[0.8% of reading +0.075% of full scale (15 counts)]	±[1.3% of reading of full scale +0.075% (15 counts)]
500 V Range	±[1.3% of reading +0.3% of full scale (15 counts)]	±[0.8% of reading +0.3% of full scale (15 counts)]	+[1.3% of reading +0.3% of full scale (15 counts)]

*1 *Valid for a period of six months or 1000 hours whichever occurs first.*

Common-Mode Rejection Ratio — ≥60 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

Maximum Resolution — 10 μV.

Response Time — <2 s.

Input Impedance — 10 MΩ paralleled by 160 pF.

Maximum Input Voltage — 500 V ac RMS, 600 V dc, not to exceed 1000 V peak.

Crest Factor — 4 (at full scale).

dB (TRUE RMS)

Zero dB Reference — 1 mW in 600 Ω (0.775 V) (dBm) Internal jumper change for 0 dB reference of 1.0000 V (dBV).

Accuracy*1

+18°C to +28°C			
20 Hz	2 kHz	10 kHz	20 kHz
+50 dB to −50 dB	0	±0.5 dB	
−50 dB to −60 dB	±0.5 dB	±1.5 dB	Typically ±2.5 dB

*1 *From 0°C to +18°C and +28°C to +50°C, add 0.6 dB to above accuracy specifications.*

Maximum Resolution — 0.1 dB.

Response Time — <2 s.

Input Impedance — 10 MΩ paralleled by <160 pF.

Maximum Input Voltage — 500 V RMS, not to exceed 1000 V peak. Equivalent to +54 dBV or +56.2 dBm.

Crest Factor — 4 (at full scale).

RESISTANCE

Response Time — <2 s in 200 Ω to 2000 kΩ ranges; <10 s in 20 MΩ range.

Maximum Input Volts — 250 V peak.

Maximum Resolution — 10 mΩ.

HI-LO Ohm Operation — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

Maximum Open-Circuit Voltage Developed — <6 V.
Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, and 20 MΩ.
Accuracy[*1]

+18°C to +28°C		
200 Ω Range	LO Ω	±[0.15% of reading +0.015% of full scale (3 counts)]
2 kΩ to 2000 kΩ Ranges	HI Ω	±[0.15% of reading +0.015% of full scale (3 counts)]
2 kΩ to 200 kΩ Ranges	LO Ω	±[0.15% of reading +0.015% of full scale (3 counts)]
2000 kΩ Range	LO Ω	±[0.3% of reading +0.015% of full scale (3 counts)]
20 MΩ Range	HI Ω only	±[0.5% of reading +0.015% of full scale (3 counts)]
0°C to +18°C and +28°C to +50°C		
200 Ω Range	LO Ω	±[0.3% of reading +0.025% of full scale (5 counts)]
2 kΩ to 2000 kΩ Ranges	HI Ω	±[0.3% of reading +0.025% of full scale (5 count)]
2 kΩ to 200 kΩ Ranges	LO Ω	±[0.3% of reading +0.025% of full scale (5 counts)]
20 MΩ Range LO Ω 2000 kΩ Range	HI Ω	±[1.2% of reading +0.025% of full scale (5 counts)]

*[*1] Valid for six months or 1000 hours whichever occurs first.*

DC AND TRUE RMS AC CURRENT

Input Signal — Must be between 5% and 100% of full scale (ac only).
Ranges — 200 μA, 2 mA, 20 mA, 200 mA, and 2000 mA.
Dc Current Accuracy — +18°C to +28°C: ±[0.2% of reading +0.015% of full scale (3 counts)]. 0°C to +18°C and +28°C to +50°C: ±[0.3% of reading + 0.025% of full scale (5 counts)].
Ac Current Accuracy — From 20 Hz to 10 kHz. +18°C to +28°C: ±[0.6% of reading +0.05% of full scale (10 counts)]. 0°C to 18°C and 28°C to 50°C: ±[0.7% of reading +0.075% of full scale (15 counts)]. Usable to 20 kHz.
Response Time — <1 s dc current, <2 s ac current.

Range	Approximate Resistance
200 μA	1.0 kΩ
2 mA	100.0 Ω
20 mA	10.2 Ω
200 mA	1.2 Ω
2000 mA	0.4 Ω

Maximum Open-Circuit Input Voltage (mA to LOW) — 250 V peak, fused with 2 A fast blow.
Maximum Floating Voltage — 1000 V peak.
Maximum Resolution — 10 nA.

TEMPERATURE

Range — −62°C to +240°C.
Resolution — 0.1°C.
Accuracy[*1]

Temperature to be measured	−62°C	+150°C	+240°C
P6601 and DM 501A calibrated as a pair	±2°C	0°C to −6°C	
P6601 and instrument not calibrated as a pair	±4°C	+2°C to −8°C	

*[*1] +18° C to +28° C ambient temperature. For 0° C to +18° C and +28° C to +50° C ambient temperatures, add 1.5° C to above limit in each direction.*

OTHER CHARACTERISTICS

Overrange Indication — Blinking display (except on 1000 V dc and 500 V ac ranges).
Measurement Rate — 3 1/3/s.
Power Consumption — ≈9 W.
Inputs — Maximum input voltage is 1000 V. The front panel Volts/Ω, or Low, or mA terminals can be floated to 1000 V peak maximum above ground, the rear input only 200 V peak. For the rear input, ac volts, ohms, and maximum input specfications are derated.

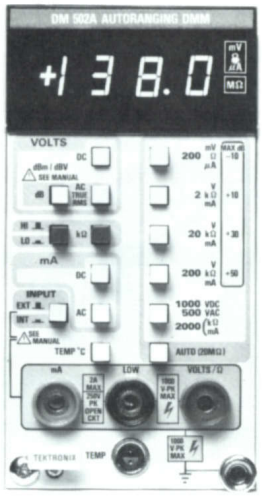
INCLUDED ACCESSORIES

One pair of test leads (003-0120-00); P6601 temperature probe (010-6601-01); instruction manual.

ORDERING INFORMATION

DM 501A Digital Multimeter **$700**
Option 02 — (Deletes P6601 Temperature Probe and temperature measurement capability) ..... **−$100**

DM 502A



Digital Multimeter

DM 502A

True RMS

Autoranging

7 Functions Including Temperature and dB

0.1% Dc Volts Accuracy

3 1/2 Digit Display

The DM 502A Digital Multimeter measures seven different functions with pushbutton convenience. Autoranging, in all modes except current, eliminates any need for operator selected ranges. The DM 502A measures dc and ac voltage, dc and ac current, dB, resistance and temperature. True RMS provides more accuracy in ac measurements on distorted, noisy, random or other nonsinusoidal ac waveforms. The resistance mode features HI-LO voltage (2 V to 0.2 V). The low voltage is user-selectable for making in-circuit ohms measurements without turning on diode and transistor junctions. The high voltage is available for testing junctions for forward and reverse resistance. The LED indicators provide a bright, readable 3 1/2 digit display.

CHARACTERISTICS

DC VOLTS

Ranges — 2000 mV, 2 V, 20 V, 200 V, and 1000 V. Automatic or manual ranging.
Accuracy[*1]

−18° to +28°C	Normal and Fast Conversion Rate
20 mV to 200 V	±[0.1% of reading +0.05% of full scale (1 count)]
1000 V	±[0.1% of reading +0.1% of full scale (1 count)]
0°C to +18°C, +28°C to +50°C	
	Normal and Fast Conversion Rate
200 mV to 200 V	±[0.2% of reading +0.1% of full scale (2 counts)]
1000 V Range	±[0.2% of reading +0.2% of full scale (2 counts)]

*[*1] Valid for a period of six months or 1000 hours, whichever occurs first.*

Common-Mode Rejection Ratio — ≥100 dB at dc. ≤80 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.
Normal-Mode Rejection Ratio — ≥50 dB at 50 Hz or 60 Hz ±0.2 Hz.
Maximum Resolution — 100 μV.
Step Response Time — 1 s within a range, +1.5 s for each range change in autoranging mode.
Input Resistance — 10 MΩ.
Maximum Input Voltage — 1000 V peak.

TRUE RMS AC VOLTS

Ranges — 200 mV, 2 V, 20 V, 200 V, and 500 V. Automatic or manual ranging (ac coupled).
Accuracy[*1]

0°C to +18°C	Normal and Fast Conversion Rate		
	20 Hz	40 Hz	20 kHz
200 mV to 200 V	±[1.5% of reading +0.3% of full scale (6 counts)]	±[0.6% of reading +0.3% of full scale (6 counts)]	
500 V	±[1.5% of reading +1.2% of full scale (6 counts)]	±[0.6% of reading +1.2% of full scale (6 counts)]	
0°C to +18°C, +28°C to +50°C	**Normal and Fast Conversion Rate**		
	20 Hz	**40 Hz**	**20 kHz**
200 mV to 200 V Range	±[1.8% of reading +0.35% of full scale (7 counts)]	±[0.8% of reading +0.35% of full scale (7 counts)]	
500 V Range	±[1.8% of reading +1.4% of full scale (7 counts)]	±[0.8% of reading +1.4% of full scale (7 counts)]	

*[*1] Valid for a period of six months or 1000 hours whichever occurs first. Typically usable to 100 kHz.*

Common-Mode Rejection Ratio — ≥60 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.
Maximum Resolution — 100 μV.
Resolution Time — 1 s within a range, +1.5 s for each range change in autoranging mode.
Input impedance — 10 MΩ paralleled by <100 pF.
Maximum Input Voltage — 500 V ac RMS, 600 V dc, not to exceed 1000 V peak.
Crest Factor — 4 (at full scale all ranges), ≤2 on 500 V range.

dB (TRUE RMS)

Zero dB Reference — 1 mW in 600 Ω (0.775 V) (dBm). Internal jumper change for 0 dB reference of 1,000 V (dBV).
Accuracy[*1]

+18°C to +28°C	20 Hz	2 kHz	10 kHz	20 kHz
+50 dB to −50 dB	±0.5 dB			
−50 dB to −60 dB	±0.5 dB	±1.5 dB	Typically ±2.5 dB	

*[*1] From 0° C to +18° C and +28° C to +50° C, add 0.6 dB to above accuracy specifications. For example, at 0° C the accuracy in the +50 dB to −50 dB range from 20 Hz to 20 kHz would be ±1.1 dB.*

Noise Level — Typically −75 dB.
Maximum Resolution — 0.1 dB.
Response Time — ≤1 s within a range, ≤1.5 s for each range change in autoranging mode.
Input Impedance — 10 MΩ paralleled by <100 pF.
Maximum Input Voltage — 500 V RMS, not to exceed 1000 V peak.
Crest Factor — 4 (at full scale), ≤2 above 40 dB.

RESISTANCE

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, and 20 MΩ. Automatic or manual ranging.

Accuracy[*1]

+18°C to +28°C	
200 Ω to 2000 kΩ Ranges	±[0.5% of reading +0.05% of full scale (1 count) + 0.2 Ω]
20 MΩ Range	±[1% of reading +0.05% of full scale (1 count)]
0°C to +18°C and +28°C to +50°C	
200 Ω to 2000 kΩ Ranges	±[0.8% of reading +0.1% of full scale (2 counts) + 0.2 Ω]
20 MΩ Range	±[1.3% of reading +0.1% of full scale (2 counts)]

*[*1] Valid for a period of six months or 1000 hours whichever occurs first.*

Response Time — ≤1 s within a range, ≤1.5 s for each range change in autoranging mode.

Maximum Input Volts — 130 V dc or ac RMS indefinitely. 230 V dc or ac RMS for 30 minutes maximum.

HI-LO Ohms Operation — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

Maximum Resolution — 0.1 Ω.

Maximum Open-Circuit Voltage Developed — ≈14 V.

DC AND TRUE RMS AC CURRENT

Ranges — 200 μA, 2 mA, 20 mA, 200 mA, and 2000 mA. Manual ranging only.

Dc Current Accuracy — +18°C to +28°C: ± [0.2% of reading +0.05% of full scale (1 count)]. 0°C to +18°C and +28°C to +50°C: ± [0.3% of reading +0.1% of full scale (2 counts)].

Ac Current Accuracy (From 40 Hz to 10 kHz) — Usable to 20 kHz. +18°C to +28°C: ±[0.6% of reading +0.3% of full scale (6 counts)]. 0°C to +18°C and +28°C to +50°C: ±[0.7% of reading +0.5% of full scale (10 counts)].

Input Resistance

Ranges	Approximate Resistance
200 μA	1.0 kΩ
2 mA	100.0 Ω
20 mA	10.2 Ω
200 mA	1.2 Ω
2000 mA	0.4 Ω

Response Time — ≤1 s.

Maximum Open Circuit Input Voltage (mA to LOW) — 250 V peak, fused with 2 A fast blow.

Maximum Floating Voltage — 1000 V peak.

Maximum Resolution — 0.1 μA.

TEMPERATURE

Range — −55°C to +200°C.

Resolution — 0.1°C.

Accuracy[*1]

+18°C to +28°C			
Temperature to be Measured	**−55°C**	**+150°C**	**+200°C**
P6601 Probe and DM 502A calibrated as a pair	±2.5°C	±3.5°C	
P6601 and instrument not calibrated as a pair	±4.5°C	±5.5°C	

*[*1] For 0°C to +18°C and +28°C to +50°C ambient temperatures, add ±1.5°C to accuracy specifications.*

OTHER CHARACTERISTICS

Overrange Indication — Blinking display (except 1000 V dc and 500 V ac).

Measurement Rate — Three per second.

Power Consumption — ≈8 W.

Inputs — Max input voltage is 1000 V. The front panel V/Ω, or Low, or mA terminal can be floated 1000 V peak max above ground, the rear input 200 V peak. For the rear input, ac volts, ohms and max input specifications are derated.

INCLUDED ACCESSORIES

One pair test leads (003-0120-00); P6601 Temperature Probe (010-6601-01); instruction manual.

ORDERING INFORMATION

DM 502A Digital Multimeter **$650**

Option 02 — (Deletes temperature probe and capability.) ..... **−$100**

DIGITAL MULTIMETER PROBES & OPTIONAL ACCESSORIES

High Voltage Probe

The High Voltage Probe will measure dc voltages from 1 kV to 40 kV with an accuracy of 1% at 25 kV. The division ratio is 1000:1. Common uses include measuring anode voltages on monitors or oscilloscopes. Probe plugs directly into the front end of the multimeter.

CHARACTERISTICS

Voltage Range — 1 kV to 40 kV dc.

Input Resistance — 1000 MΩ.

Division Ratio — 1000:1.

Overall Accuracy — 20 kV to 30 kV 2%.

Upper Limit Accuracy — Changes linear from 2% at 30 kV to 4% at 40 kV.

Lower Limit Accuracy — Changes linear from 2% at 20 kV to 4% at 1 kV.

Input Z at Meter — 10 MΩ required.

Included Accessory — Instruction manual.

High Voltage Probe

Order 010-0277-00 ..... **$135**

P6420 RF Probe

The P6420 RF Probe is compatible with DMM's that have an input impedance of 10 MΩ and comes with a two meter cable.

CHARACTERISTICS

Voltage Range — 5 V to 25 V RMS (70.7 V p-p).

Ac to Dc Transfer Ratio Accuracy — 0.5 V to 5 V RMS ±10% (+15°C to +35°C). 5.0 V to 25 V RMS ±5% (+15°C to +35°C).

Frequency Response — 100 kHz to 300 MHz (±0.5 dB), 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB).

Input Capacitance — ≈3.7 pF.

Maximum Input Voltage — 42.4 V (peak ac + dc).

Length — Probe only 96 mm. Cable only 2 meters.

INCLUDED ACCESSORIES

Retractable probe tip (013-0097-01); BNC female to dual banana adaptor (103-0090-00); alligator clip (344-0046-00); probe holder (352-0351-00); ground lead (175-0849-00) 76.2 mm (3 in); ground lead (175-1017-00) 152.8 mm (6 in); electrical insulating sleeve (166-0404-01); 2 replaceable probe tips[*1]; instruction manual.

*[*1] Available in package of 10 only, Order 206-0230-03.*

ORDERING INFORMATION

P6420 RF Probe, 2 m Cable Included,

Order 010-6420-03 ..... **$138**

For a 1 meter length cable (does not change specifications). Order 175-1661-00 ..... **$27**

For a 3 meter length cable (does not change specifications). Order 175-1661-02 ..... **$27**

P6601 Temperature Probe

The P6601 Probe is a temperature measuring device designed to operate with the DM 502A and DM 501A Digital Multimeters. The temperature sensing element consists of a thin-film platinum resistor on the tip of the probe. Measurements are made by touching the probe tip to the surface whose temperature is in question. The thermal signal is transmitted to the associated digital multimeter through a two-conductor cable.

The thermal time constant on the P6601 Probe is 0.5 seconds ±0.2 seconds. The P6601 is totally immersible except in liquids that are not compatible with Dow Corning 308 molding compound, BeO, silicone rubber, or epoxy adhesives. The sensor and tip are limited to a max of +240°C, and cable is limited to a max of +140°C.

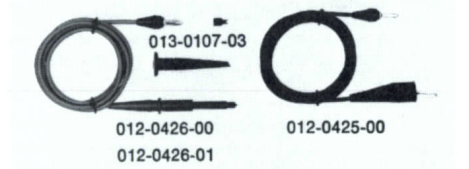
Included Accessory — Instruction manual.

P6601 Temperature Probe

Order 010-6601-01 ..... **$210**

DMM OPTIONAL ACCESSORIES

The following accessories may be ordered as options for use with any of the three TM 500/TM 5000 Digital Multimeters.



Test Lead — Black, 4 ft. Order 012-0425-00 ..... **$12**

Test Lead — Red, 4 ft. Order 012-0426-00 ..... **$17.50**

Test Lead — Black, 4 ft. Order 012-0426-01 ..... **$17.50**

Test Lead — Set (012-0425-00, 012-0426-00, 013-0107-03). Order 012-0427-00 ..... **$29**

Adaptor — Female BNC to Dual Banana Order 103-0090-00 ..... **$7.50**

Additional accessories begin on page 439.

The TM 500 Pulse Generator family offers a wide variety of capabilities suitable for most pulse testing applications. Whether testing wide-band systems, simulating data transmission signals, or driving a laser, the versatile TM 500 Pulse Generators have the capabilities to meet your needs.

Particularly important in today's digital world is the capability to generate a variety of pulse signals compatible with the key logic families.

The PG 507 features complementary dual outputs making it ideally suited for digital applications. The dual output feature is particularly useful when working with ECL logic families.

Similar to the PG 507 Pulse Generator is the 50 MHz PG 508 featuring independently variable risetimes and falltimes. The PG 508's high level performance and versatility cover a broad range of test and measurement applications.

The accurate 50 ohm output impedances of the PG 507 and PG 508 deliver clean signals into logic families, reactive loads, or at the end of an unterminated cable. These 50 MHz multipurpose generators are also designed for high level performance on high impedance circuits (MOS, HTL, and CMOS logic).

In 50 ohm systems, the PG 501 and PG 502 are designed to be compatible with common digital integrated-circuit families (TTL, DTL and ECL), in repetition rates, amplitudes and transition times.

The TM 500 Pulse Generators' wide range of features afford you ease of operation even on the most challenging test and measurement problems.

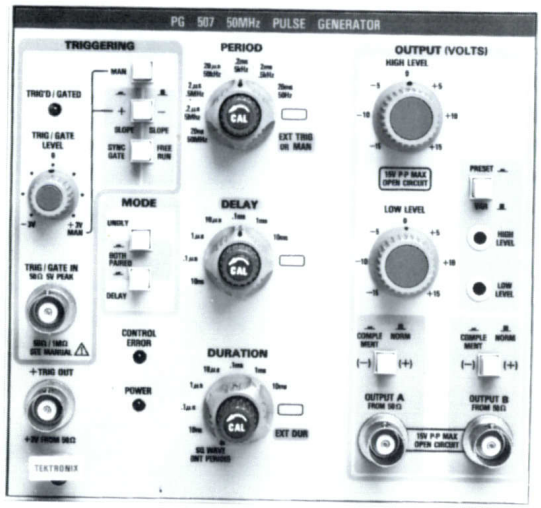
PULSE GENERATORS COMPARISON OF CHARACTERISTICS

	PG 507	PG 508	PG 501	PG 502
Pulse Period	≤20 ns to ≥200 ms (50 MHz to 5 Hz)		≤20 ns to ≥200 ms (50 MHz to 5 Hz)	≤4 ns to ≥100 ms (250 MHz to 10 Hz)
Pulse Duration Duty Factor	≤10 ns to ≥100 ms		≤10 ns to ≥100 ms	≤2 ns to ≥50 ms
	≥70% to 0.2 μs period, ≥50% at 20 ns period			≥50%
Squarewave Mode	Yes	Yes	No	Yes
Pulse Delay Duty Factor	≤10 ns to ≥100 ms*1	≤10 ns to ≥100 ms*1	Fixed, 20 ns from external trigger	Fixed, 17 ns from external trigger
	≥70% to 0.2 μs period, ≥50% at 20 ns period			
Double Pulse	Yes	Yes	No	No
Transition Times	Fixed, ≤3.5 ns, ≤4 ns @ >5 V	≤5.5 ns to ≥50 ms, Independently variable up to 100:1	Fixed, ≤3.5 ns	Fixed ≤1.0 ns
Aberrations	≤5% p-p +25 mV into 50 Ω load	≤5% p-p +50 mV for pulse within ±5 V into 50 Ω load	Within 3.5% at 5 V into 50 Ω load	Within 5% at 5 V p-p (durations ≥5 ns)
Amplitude: Into 50 Ω	≥7.5 V p-p, ±7.5 V window	≥10 p-p, ±10 V window	≥5 V	5 V, ±5 V window
Open Circuit	≥15 V p-p, ±15 V window	≥20 p-p, ±20 V window	Not specified	5 V, ±5 V window
Source Impedance	50 Ω	50 Ω	Not specified	1 kΩ or 50 Ω
Simultaneous Outputs	Yes, complementary	No	Yes, positive and negative	No
Pulse Coincidence	≤1 ns at 50% amplitude	NA	≤1 ns at 50% amplitude	NA
Output Controls	Independent pulse top and pulse bottom, normal or PRESET		Independent amplitude controls for + and − outputs, no offset	Independent pulse top and pulse bottom
Normal/Complement	Yes, both outputs	Yes	No	Yes
Remote Amplitude	Rear interface inputs	Rear interface inputs	No	No
Locked On Mode	No	No	Yes	No
Back Termination	Always back terminated	Always back terminated	No	Yes, switchable
External Input	1 MΩ to 50 Ω input impedance	1 MΩ or 50 Ω input impedance	50 Ω input Z	50 Ω input Z
Trigger Level	−3 V to +3 V, 80 mV p-p sensitivity to 10 MHz 250 mV p-p to 50 MHz TRIG'D/GATED light		+1 V required	+1 V required
Slope	+ or −	+ or −	+ Only	+ Only
Trigger Mode	Yes	Yes	Yes	Yes
Manual Trigger	Yes	Yes	No	Yes
Duration Mode	Yes	Yes	Yes	Yes
Gate Mode	Yes	Yes	No	No
Counted Burst	Yes, with DD 501*2	Yes, with DD 501*2	No	No
Trigger Output (50% Squarewave or Follows External Signal)	≥+2 V from 50 Ω approximately 35 ns prior to pulse output (23 ns in squarewave or EXT DUR modes)		≥+2 V from 50 Ω, approximately 8 ns prior to pulse output	≥+2 V from 50 Ω, approximately 10 ns prior to pulse output
Custom Timing Positions	User installed capacitors	User installed capacitors	No	No
Control Error Light	Yes	Yes	No	No

*1 *Add 60 ns for delay from external trigger.*
*2 *Exact count to 20 MHz, usable to 50 MHz.*

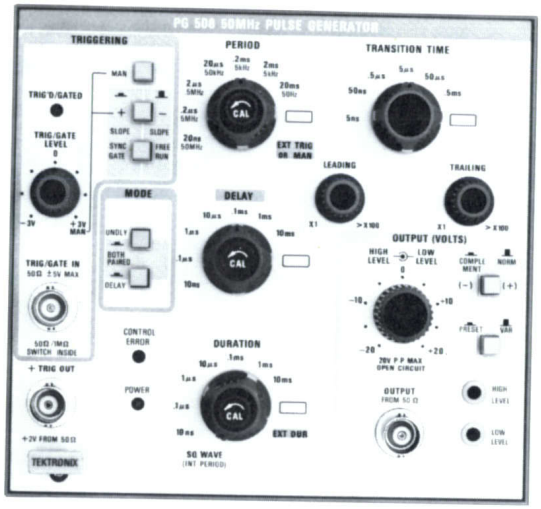
For recommended accessories — refer to page 458.

PG 507



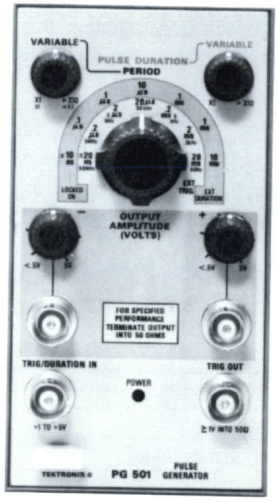
50 MHz Dual Output Pulse Generator

PG 508



50 MHz Pulse Generator

PG501



50 MHz Pulse Generator

PG 507

Dual Outputs with Tracking Level Controls

Normal or Complement Pulse Output on Both Channels

15 V Output in a ±15 V Window into High Impedance, 7.5 V into 50 Ω

3.5 ns Risetime/Falltime

The PG 507 is a high performance, 50 MHz pulse generator designed specifically for logic design applications.

The PG 507 features complementary dual outputs which greatly increase its applicability in logic design areas, especially interfacing within systems or to peripherals. For instance, the complementary outputs allow simulation of line drivers or opposite phase clocks.

The PG 507 also offers versatility to the design engineer in an analog environment. For example, the dual outputs can be used to test differential input amplifiers or multiplexers.

The PG 507 features four output modes: normal complement mode (Channel A output positive going, Channel B output negative going), opposite phase complement mode (Channel A output negative going, Channel B output positive going), simultaneous negative mode (Channel A output negative going, Channel B output negative going), and simultaneous positive mode (Channel A positive going Channel B output positive going).

In addition, the Output High Level and Low Level voltage controls track between channels, making amplitude settings easy.

This unique output flexibility within the normal and complement modes is particularly useful in logic design or control applications requiring simultaneous signals.

Included Accessory — Instruction manual.

Order PG 507 50 MHz Pulse Generator **$2,060**

P6062B, P6108 and P6122 Probes are recommended, see pages 455, 452 and 451 respectively.

PG 508

Independently Variable Rise and Falltimes to 5 ns

20 V Output in a ±20 V Window to Hi Impedance, 10 V into 50 Ω

Normal or Complement Output

The PG 508 50 MHz Pulse Generator is a highly versatile, general purpose pulse generator. The circuitry of the PG 508 is designed so that rise and fall waveforms closely simulate real world waveforms. This capability is particularly useful in research and development applications demanding versatility in rise and falltimes like testing of amplifiers, slew rate testing, comparator simulation and logic circuitry performance tests.

For example, controllable rise and falltimes are extremely desirable when working with CMOS where logic power consumption increases with slower risetimes. Also, variable rise and falltimes are used to reduce ringing (transient distortion) problems associated with too fast a pulse.

The PG 508 features a vernier control on the rise and falltimes controllable from 100 to 1. This completely overlaps the next decade range and increases the PG 508's versatility in applications simulating different rise and falltimes, especially the output of nonlinear devices. This overlap feature can also be used to generate a ramp signal or simulate unequal slew rates in an amplifier.

Also adding to the simplicity of using the PG 508 is the capability of changing output amplitude while variable rise and falltimes remain constant.

Included Accessory — Instruction manual.

ORDERING INFORMATION

PG 508 50 MHz Pulse Generator **$2,025**

PG 508T 50 MHz Pulse Generator **$2,390**

(Includes PG 508, TM 503 Mainframe, and 016-0195-03 Blank Panel.)

For counted Burst, order the

DD 501 Digital Delay (page 365) **$1,310**

Suggested 10 in BNC 50 Ω cable (2 required) for interconnecting PG 508 and DD 501:

Order 012-0208-00 ..... **$20**

P6062B, P6108 and P6122 Probes are recommended, see pages 455, 452 and 451 respectively.

PG 501

5 Hz to 50 MHz

Simultaneous Plus and Minus Outputs

5 V and 3.5 ns into 50 Ω

Independent Period and Duration Controls

Trigger Out

The PG 501 is a 50 MHz Pulse Generator featuring simultaneous plus and minus outputs, a wide range of pulse-period durations and duty factors, trigger output and external trigger/duration input. Its performance and ease of operation make it well-suited to basic digital and analog applications.

Included Accessory — Instruction manual.

Order PG 501 50 MHz Pulse Generator **$735**

Manual (One-Shot) Trigger Generator

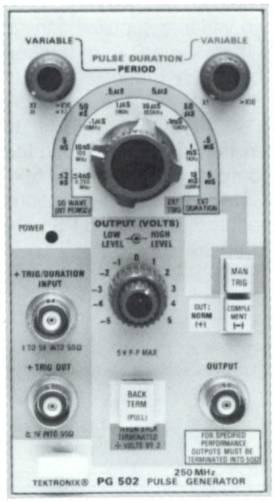
The Manual (one-shot) Trigger Generator is used for manually initiating a pulse or complete train of events with instruments which do not have a manual trigger button or where a remote operation capability is desired, such as with some oscilloscopes and the PG 501.

The internal trigger generator circuitry eliminates contact bounce, but will generate pulses as rapidly as the operator can manually cycle the pushbutton.

The output pulse is nominally 2 ms in width and 3 V in amplitude (from 50 Ω) with a rapid rise and falltime.

Order 016-0597-00 ..... **$170**

PG 502

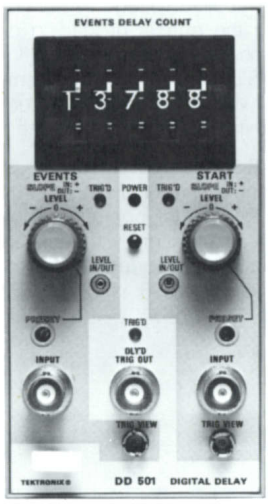


250 MHz Pulse Generator

284

Pulse Generator

DD501



Digital Delay

PG 502

10 Hz to 250 MHz

1 ns Risetime

5 V Output ±5 V Window

Independent Pulse Top and Bottom Level Controls

Selectable Internal Reverse Termination

Manual Trigger Button

The PG 502 features fast rise and falltimes, independent top and bottom pulse levels, and adjustable pulse duration. The fast rep rate makes the instrument ideal for design and testing of fast logic and switching circuits.

Included Accessory — Instruction manual.

Order PG 502 250 MHz Pulse Generator **$2,590**

50 Ω Precision Coaxial Cable

For use with the PG 502, PG 506, and SG 503. These instruments are internally calibrated for use with this 3 ft 50 Ω coaxial cable into a 50 Ω load.

50 Ω Cable Order 012-0482-00 ..... **$25**

284

70 ps or Less Risetime Pulse

Sinewave and Squarewave Outputs

CHARACTERISTICS

Pulse Output — 70 ps or less risetime with a pulse width of more than 1 μs and a repetition rate of ≈50 kHz. Aberrations immediately following positive-going transitions are < ±3%, 3% total p-p; after 2 ns < ±2%, 2% total p-p. Pulse amplitude is more than +200 mV into 50 Ω. Source resistance is 50 Ω.

Squarewave Output — Periods of 10 μs, 1 μs, or 100 ns. Amplitude is 10 mV, 100 mV, or 1 V into 50 Ω.

Sinewave Output — Periods of 10 ns or 1 ns. Output amplitude is 100 mV into 50 Ω.

Trigger Output — Squarewave, sinewave, or pretrigger pulse output, depending on the selected main signal output. Amplitude is 200 mV, accurate within 40%. When Pulse Output is selected, the trigger can be switched to arrive 5 ns ±5 ns, or 75 ns ±5 ns ahead of the main pulse. Risetime is 3 ns or less; pulse width is 10 ns or greater.

Output	Period	Timing Accuracy	Amplitude Accuracy 1 V	100 mV	10 mV
Pulse	20 μs	±10%			
Square-wave	10 μs 1 μs	±0.5%	±0.5%	±1%	±1.5%
	100 ns	±0.05%*1	±2%*2	±2.5%*2	±3%*2
Sinewave	10 ns 1 ns	±1%		±20%	

*1 Crystal controlled.
*2 20 ns after transition.

The 284 is not part of the TM 500 Series, and does not require the use of a separate mainframe.

Included Accessory — Instruction manual.

Order 284 Pulse Generator **$2,000**

DD 501

Digital Events Delay

Delay to 99,999 Events

Divide by N up to 20 MHz

Pulse Counting to 65 MHz

Time Delay with Ext Clock

Compatible with Most Attenuator Probes

The DD 501 Digital Delay is an events-counting device which can be used with pulse, function and clock generators in such applications as precise digital delay between two related events, divide-by-N frequency divider, precision gate generator, counted burst output from a gated pulse or frequency generator, etc.

The DD 501 has basically two modes of operation. In the gating mode, the DD 501 generates a gate which starts with the application of a start pulse and continues until a selected number of event pulses have occurred. It can be used for generating a counted burst of N pulses when used with a pulse generator capable of being gated. Tektronix generators capable of being gated by the DD 501 are the FG 501A, FG 502, FG 504, FG 507, FG 5010, PG 507, and PG 508.

In the delayed trigger mode, the DD 501 generates a trigger pulse after the selected number of event pulses have occurred. Besides being used strictly for generating precision delays, the delayed trigger mode can also be used as a frequency count-down divider for any frequency up to 65 MHz. In both modes, the desired number of events (from 0 to 99,999) is selected by front-panel thumbwheel switches.

Trigger slope and level controls for both the Start and Events inputs permit use with a wide variety of applied signals. Both inputs are compatible with Tektronix attenuator probes. In special applications, the trigger levels may be remotely set by application of analog voltages through the front-panel Level In/Out jacks.

CHARACTERISTICS

EVENTS DELAY

Count — 10 to 99,999 events.

Maximum Count Rate — 65 MHz.

Insertion Delay — 30 ns or less from final event to trigger output pulse.

Recycle Time — 50 ns or less.

Reset — Manually resets delay counter.

INPUT CHARACTERISTICS

(All characteristics apply to both events and start inputs).

Input Impedance — 1 MΩ, 20 pF.

Slope — Either + or −, selectable.

Sensitivity — 85 mV p-p at 30 MHz.

Frequency Response — Up to 65 MHz at 120 mV sensitivity.

Minimum Detectable Pulse Width — 5 ns,

Threshold Level Range — From −1.0 V to +1.0 V (−10 V to +10 V with 10X probe). Can be externally programmed or monitored at front panel jacks.

Trigger View Out — Threshold detector output, at least 0.5 V (200 Ω or less source impedance).

Events Triggered Light — Visual indication that events are being detected.

Start Triggered Light — Visual indication that delay is in progress.

TRIGGER OUTPUT

Pulse Width — Width of events pulse plus 6 ns or less.

Voltage Swing — + 0.8 V or less to at least + 2.0 V with 3 TTL loads (≈5 mA).

Light — Indicates output trigger.

Included Accessory — Instruction manual.

Order DD 501 Digital Delay **$1,310**

PRODUCT SUMMARY

Design engineers require power supplies that are flexible enough to meet their needs...and compact enough to allow a complete, custom-designed test system to fit neatly on a crowded workbench. To assure versatility and convenience in your test system, the TM 500 power supplies can be rear interfaced with other instruments to reduce front panel clutter while providing capabilities not otherwise available. For example, the output level can be monitored via the rear interface by a companion TM 500 digital multimeter without the need for extra cabling at the front of the instrument. Remote sensing terminals available at the rear panel allow sensing of the applied voltage at the load, thereby minimizing the effects of loading on the supply. In addition, the plus and minus floating outputs of the PS 503A can be programmed remotely, by either voltage programming or resistance programming, via the rear interface.

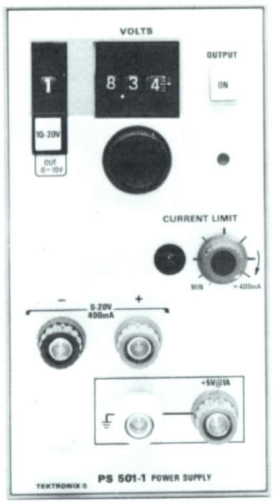
The PS 501-1 supplies 0 to 20 volts (floating) and adjustable current limiting to 400 milliamps, with constant current operation above the limit setting. A multiturn dial with mechanical digital readout provides accurate setting of the output voltage. The fixed 5 volt supply supplies up to 1 amp.

The PS 503A provides a floating dual −20 to 0 and 0 to +20 volt variable supply, plus the 5 volt 1 amp supply. The two variable supplies can be set individually and then varied in a tracked mode with a single control. By grounding one of the two outside terminals of the variable supply you can have a 0 to 40 volt supply with up to 1 amp of current when the PS 503A is operated in the high-power compartment of a TM 504, TM 506, RTM 506, or TM 5006. Full descriptions of the IEEE-488 compatible PS 5004 and PS 5010 appear on pages 366 and 367.

	PS 501-1		PS 503A		PS 5004	PS 5010	
Power Supplies	**0 to 20 V**	**+5 V**	**+ and −20 V**	**+5 V**	**0 to 20 V**	**+ and −32 V**	**Logic**
Floating	350 V (dc + peak ac)	Ground Referenced	350 V (dc + peak ac)	Ground Referenced	42 V (dc + peak ac)	150 V peak front panel, 42 V peak rear interface	Ground Referenced
Voltage Range	0 to 20 V	5 V	0 to ±20 V	5 V	0 to 20 V	0 to ±32 V	4.5 to 5.5 V
Current Range High Power Compartment	40 mA to 400 mA	1 A	100 mA to 1 A	1 A	0 to 300 mA	50 mA to 0.760 A (1.6 A up to 15 V)	100 mA to 3.0 A
Standard Compartment			40 mA to 400 mA			50 mA to 400 mA (0.750 A up to 15 V)	
Voltage Mode Overall Accuracy (total effect)					±(0.01% +500 μV)	±(0.5% +20 mA)	±50 mV
Accuracy	0.5%						
Source Effect (line regulation)	5 mV	50 mV	5 mV	5 V ±0.25 V	0.005%	±(0.1% +2 mV)	1 mV
Load Effect (load regulation)	1 mV for a 400 mA change in load current	100 mA for 1 A change in load current	3 mV for 1A change in load current	100 mV for 1 A change in load current	500 μV for 300 mA change in load current	10 mV for 1 A change in load current 1 mV using remote sensing	
Temperature Coefficient	Typically <0.01%/°C		Typically <0.025%/°C		≤(30 ppm +100 μV/°C	Typically <(0.01% +0.1 mV)/°C	Typically <500 μV/°C
Resolution (step size)	1.6 mV		50 mV		500 μV	10 mV up to 10.0 V 100 mV above 10.1 V	10 mV
PARD (ripple and noise) (Periodic and Random Deviations)	0.5 mV p-p 0.1 mV RMS	5 mV p-p	3 mV p-p	5 mV p-p	≤3 mV p-p	10 mV p-p 1 mV RMS	10 mV p-p 2 mV RMS
Current Mode Overall Accuracy (total effect)	Current limit	Current limit	Current limit	Current limit	Constant current 10 mA to 300 mA	Constant current ±(5% +20 mA)	Current limit with fold back ±(5% +20 mA)
Source Effect (line regulation)						1 mA	
Load Effect (load regulation)						10 mA	
Temperature Coefficient						Typically <(0.1% +1 mA)/°C	
Resolution (step size)					2.5 mA	50 mA	100 mA
PARD (ripple and noise)						10 mA p-p 5 mA RMS	
Display Voltage	10 turn potentiometer with a three digit in-line dial and range pushbutton	None	Voltage indicator lights. Brightness varies with output voltage	None	Five digit LED	Each supply has three digit LED display shared between voltage and current	
Current	LED indicator	None	Current limit indicator lights	None			
Programmability	Voltage Programming	None	Voltage and resistance programming	None	IEEE Standard 488-1978 (GPIB) full listen and talk capability with interrupt status reporting		
Tracking	None	None	Ratio	None	None	Arithmetric	None
Remote Sensing	Rear interconnect		Rear interconnct		Rear interconnect	Rear interconnect	
Output On/Off	Yes		Yes		Yes	Yes	
Mainframe Capability	TM 500/TM 5000 Series		TM 500/TM 5000 Series		TM 5000 Series	TM 5000 Series	

For recommended accessories — refer to page 457.

PS 501-1



Power Supply

PS 501-1

- Floating Output, 0-20 V
- 0 to 400 mA
- Precise Regulation
- Low Ripple and Noise
- Fixed Output + 5 V at 1 A
- 3 1/2 Digit Ten Turn Dial

The PS 501-1 features precise regulation and better than 2 mV resolution (setability) over a 0 V to 20 V range.

CHARACTERISTICS

Output — 0 V to 20 V dc.
Maximum Rated Current — 400 mA to +30°C derating to 300 mA at +50°C.
Accuracy — ±(0.5% + 10 mV).
Current Limit — <40 to 400 mA.
Line Regulation — Within 5 mV for a +10% line voltage change.
Load Regulation — Within 1 mV for a 400 mA load change.
Ripple and Noise — 0.5 mV p-p or less; 20 Hz to 5 MHz.
Temperature Coefficient — Typically <(0.01% +0.1 mV)/°C.
Minimum Resolution — Typically 1.6 mV.
Transient Recovery Time — ≤20 μs to recover within 20 mV of final output voltage after a 400 mA change in output current.
Included Accessory — Instruction manual.

Order PS 501-1 Power Supply **$500**

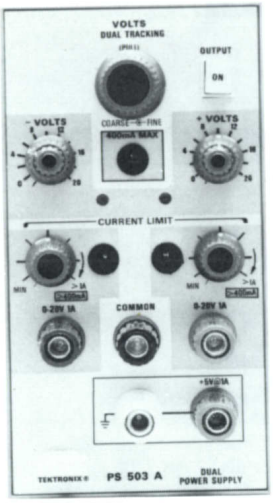
COMMON CHARACTERISTICS (PS 501-1, PS 503A) 20 V FLOATING SUPPLIES

Primary Power Input — Determined by mainframe (TM 501, TM 503, etc).
Output — Floating, isolated for 350 V dc + peak ac above ground.
Stability — Typically (0.1% +5 mV) or less drift in 8 hours of constant line, load, and temperature.
Indicator Lights — Voltage variation and current limit.

+5 V GROUND-REFERENCED SUPPLY

Output — 5 V nominal, ±0.25 V at 1 A.
Load Regulation — Within 100 mV with a 1 A load change.
Line Regulation — Within 50 mV for a 10% line voltage change.
Ripple and Noise (1A) — 5 mV p-p or less, 20 Hz to 5 MHz.
Stability — Typically 30 mV or less drift in 8 hours.
Overload Protection — Automatic current limiting and over-temperature shutdown.

PS 503A



Triple Power Supply

PS 503A

- Independent + and − Controls
- Dual Tracking Voltage Control
- 0 V to ±20 V at 1 A (in High-Power Compartment)
- Fixed Output + 5 V at 1 A
- Remote Resistance Programming
- Over-Voltage Protection Standard

The PS 503A features superior dual tracking performance, over-voltage protection, and remote resistance programming of voltage. When operated in the high-power compartment of a TM 504 or TM 506 Mainframe, the PS 503A provides up to 1 amp from both 0 to 20 volt supplies.

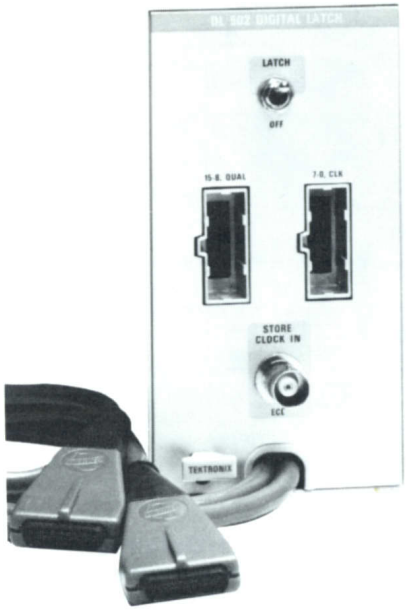
CHARACTERISTICS

±20 V FLOATING SUPPLIES

Outputs — 0 V to ±20 V dc with respect to the common terminal or 0 to 40 V dc across the + and − terminals. Outputs can be varied independently or at a constant ratio.
Maximum Rated Current — 400 mA (1 A in high power compartment to +30°C derating to 300 mA (750 mA) at +50°C.
Tracking Mode Offset Error — If the two supplies are set independently to any given voltage ratio and then varied by use of the Volts Dual Tracking control, the two supplies will maintain the same voltage ratio as initially set within ±50 mV.
Current Limit — Adjustable from <100 mA to 1 A (high-power compartment) or <40 mA to 400 mA (standard compartment) on each supply.
Load Regulation — Within 3 mV for 1 A change (high-power compartment) or 1 mV for 400 mA change (standard compartment).
Ripple and Noise — 3 mV p-p or less at 1 A load (high-power compartment). 0.5 mV p-p or less at 400 mA load (standard compartment).
Indicators — Individual voltage indicators and current limiting indicators for both + and − supplies. Standard compartment (400 mA) indicator.
Included Accessory — Instruction manual.

Order PS 503A Power Supply **$620**

DL 502



Digital Latch

DL 502

- 16 Channel Latching Capability
- Captures Glitches as Narrow as 5 ns at Probe Tips
- Allows Expansion of Information Time Frame
- TM 500 Compatibility
- Companion For Logic Analyzers

The DL 502 Digital Latch extends the logic analyzer's measurement capabilities. The Digital Latch aids in detecting narrow pulses in a data stream that cannot be captured by a logic analyzer alone. The 16 channel latch captures asynchronous glitches of less than one sample interval or as narrow as 5 ns.

In asynchronous measurements without latching capability, high speed data anomalies go undetected if they do not appear on a clock edge. The DL 502 Digital Latch captures the glitch and holds it until the next clock edge, then expands and displays it for one sample interval.

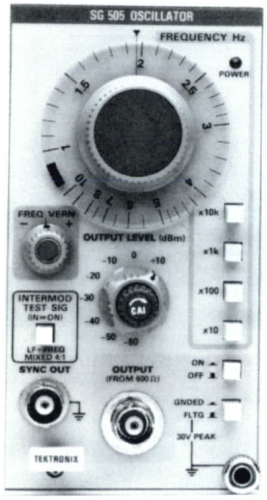
The DL 502 Digital Latch plugs into any compartment of a TM 500/TM 5000 Mainframe and can be used in a variety of configurations.

CHARACTERISTICS

Minimum Pulse Width to Initiate Latch — 5 ns.
Minimum Amplitude to Initiate Latch — 500 mV centered at threshold.
Minimum Sample Interval Asynchronous Clock — 50 ns.
Included Accessories — Six inch BNC cable; instruction manual.

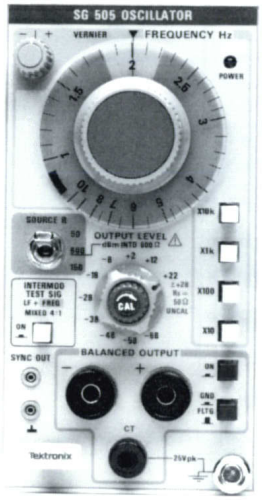
Order DL 502 Digital Latch **$1,900**

SG 505 Option 01



Oscillator

SG 505 Option 02



Oscillator

SG 505/Option 01/Option 02

10 Hz to 100 kHz Sinewave Output

Ultra-Low Distortion: <0.0008% THD (Typically 0.0003%)

Floating or Grounded Output

600 Ohm Source Impedance

Vernier Frequency Control

Fully Balanced Output (Option 02)

Calibrated Output to +28 dBm (Option 02)

Selectable Source Impedance (Option 02)

Intermodulation Test Signal (Option 01 & 02)

The SG 505 Oscillator generates an ultra-low distortion sinewave over the frequency range from 10 Hz to 100 kHz (<0.0008% THD, typically 0.0003% between 20 Hz and 20 kHz). In the standard and Option 01 units the output can be floated or referenced to chassis ground. In the Option 02 unit, the output is fully balanced and floating with a center tap which may be attached to system ground or to either side of the output signal. The oscillator also provides a fixed amplitude ground referenced sinewave at the Sync Out connector, which is identical in frequency to the signal from the Output connector.

Option 01 adds an intermodulation test signal function. This signal consists of a selectable 60 Hz or 250 Hz mixed with the selected frequency in a 4:1 amplitude ratio.

For communications and broadcast applications, the Option 02 provides a fully balanced output of +28 dBm into 600 ohms from 50 ohms. A ten-position step attenuator (10 dB per step) and a variable attenuator provide continuous attenuation of signal amplitude to below −78 dBm into 600 ohms.

A front panel switch allows the selection of three different source resistances: 50 ohms for low impedance applications (improves measurement accuracies on long cable runs and reduces loading effects), 150 ohms for matching microphone circuits, and 600 ohms for complying with audio/communication industry standard and general purpose applications.

Option 02 also includes the intermodulation test signal capability of the Option 01.

CHARACTERISTICS (Std and Opt 01)

MAIN OUTPUT

Frequency Range — 10 Hz to 100 kHz in four overlapping bands. Accurate within 3% of dual setting (with Vernier at center). Vernier Range is at least ±1% of frequency setting.

Calibrated Output — Selectable from +10 dBm to −60 dBm into 600 Ω in eight 10 dB steps. Accurate to within 0.2 dB at +10 dBm and 1 kHz. Step accuracy is ±0.1 dB/10 dB step. An uncalibrated control provides continuous variation from at least +2.2 dB to <−10 dB from calibrated positon.

Amplitude Response — Level flatness ±0.1 dB from 10 Hz to 20 kHz (1 kHz ref); within 0.2 dB from 20 kHz to 100 kHz (excluding >50 kHz on −60 dB output level range).

Harmonic Distortion — <0.0008% (−102 dB) THD from 20 Hz to 20 kHz (typically 0.0003%); 0.0018% (−95 dB) THD from 10 Hz to 20 Hz, and from 20 kHz to 50 kHz; 0.0032% (−90 dB) THD from 50 kHz to 100 kHz (R_L ≥600 Ω).

Output Impedance — 600 Ω ±2%; floating or grounded through ≈30 Ω. Output impedance does not change with Output On/Off selection. Max floating voltage ±30 V peak.

Maximum Output Voltage — At least 6 V RMS open circuit; 3.16 V RMS (+10 dBV or +12.2 dBm) into 600 Ω.

SYNC OUTPUT

Signal — 200 mV RMS ±20% sinewave to 20 kHz, at least 120 mV RMS at 100 kHz.

Frequency — Same as main output.

Impedance — Nominally 1 kΩ, ground referenced and isolated from main output.

REAR INTERFACE SIGNALS

Buffered Main Output — Buffered version of actual output signals from front panel connector. ≈300 Ω Output impedance.

Sync Output — Same as front panel Sync Output except output impedance is ≈50 Ω.

OPTION 01 IM TEST SIGNAL

Selecting the IM Test Signal causes a LF sinewave to be mixed with the normal oscillator signal in a 4:1 amplitude ratio.

LF Frequency — Internally selectable 60 Hz (±1 Hz) or 250 Hz (±3 Hz).

Main Output — Composite p-p output within 0.2 dB of normal oscillator mode output.

Residual IMD — Typically <0.0005% from 2.5 kHz to 10 kHz.

Sync Output — LF signal component only, 200 mV RMS ±20%.

CHARACTERISTICS (Opt 02)

MAIN OUTPUT

Calibrated Output — Selectable from +22 dBm to −68 dBm into 600 Ω in ten 10 dB steps. Accurate to within 0.2 dB at +22 dBm and 1 kHz. Step accuracy is ±0.1 dB/10 dB step or 20 dB step change. An uncalibrated control provides continuous variation from <−10 dB to +0.3 dB from calibrated position.

Harmonic Distortion — <0.0008% (−102 dB) THD from 20 Hz to 20 kHz (typically 0.0003%); 0.0018% (−95 dB) THD from 10 Hz to 20 Hz, and from 20 kHz to 50 kHz; 0.0056% (−85 dB) THD from 50 kHz to 100 kHz (R_L ≥600 Ω).

Output Impedance — Selectable 600 Ω ±2%, 150 Ω ±2% or 50 Ω ±3% floating or grounded through ≈30 Ω. Output impedance does not change with Output On/Off selection. Impedance to CT is ½ the selected impedance. Maximum floating voltage ±25 V peak.

Maximum Output Voltage — At least 21 V RMS open circuit; 19.45 V RMS (+28 dBm) into 600 Ω from 50 Ω.

Balance — ≤0.5% mismatch of output open-circuit voltages referenced to CT for f ≤20 kHz with output Grounded.

INCLUDED ACCESSORIES

Cable assembly for sync output (175-1178-00); instruction manual.

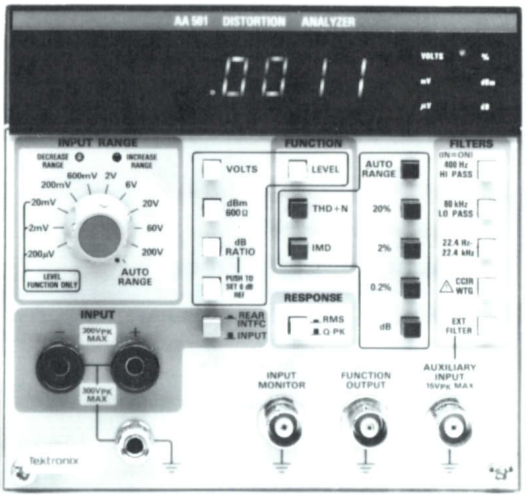
ORDERING INFORMATION

SG 505 Oscillator **$740**

Option 01 — IM Test Signal ..... **+$205**

Option 02 — Oscillator (Includes Option 01) ..... **+$670**

AA 501 Option 02



Distortion Analyzer

AA 501

Fully Automatic: No Level Setting, Tuning or Nulling

Level, Total Harmonic Distortion, and dB Ratio Measurements

Total System Harmonic Distortion Plus Noise (THD+N) <0.0025%

<3 μV Residual Noise

Digital Readout Plus Analog-Like "Bar Graph" for Peaking and Nulling

IMD to SMPTE, DIN, and CCIF (Option 01)

The AA 501 Distortion Analyzer provides completely automatic measurement of level, total harmonic distortion plus noise (THD+N), and (with Option 01) Intermodulation Distortion. Automatic set level, automatic tuning, automatic nulling of the fundamental, and autoranging of the display all combine to permit completely hands-off operation once the mode is selected. Just apply the signal of interest and read the 3½-digit display. A novel analog-like bar graph simulates an analog meter to assist in peaking and nulling of applied signals.

With Option 01, intermodulation distortion measurements can be made to any of the three common standards: SMPTE, DIN, or CCIF. Internal circuitry automatically identifies the signal being used and selects the proper filtering circuits to perform the measurement.

DB ratio measurements may be referenced either to 774.6 millivolts (1 milliwatt in 600 ohms) or to a selected applied signal. The 0 dB reference memory remembers the selected level, and all subsequent measurements are referenced to that level.

The AA 501 allows readings to be expressed in true RMS or average response, RMS calibrated. Although true RMS is more accurate in most applications, the average response permits comparisons with measurements previously taken with older instrumentation.

The fundamental frequency range of the AA 501 is 10 Hz to 100 kHz, with harmonics measured out to 300 kHz.

Any one of four built-in frequency-weighting filters may be switched into the signal paths for preconditioning of the signal to be measured. Provision is also made to permit the use of a user-selected filter as well.

A dc level, which is a function of the display readout, is available at the rear panel of the AA 501.

An Input Monitor connector and a Function Output connector are provided to permit oscilloscope display of the input signal or the result of the filter in the THD+N measurement.

The Option 02 version of the AA 501 is especially designed for use in accordance with CCIR recommendation 468-2 and DIN 45405 (typically used in Europe). In the Option 02 version, the 30 kHz filter and the "A" weighting filter of the standard unit are replaced by a 22.4-Hz-to-22.4-kHz filter and a CCIR-weighting filter, respectively, and the average responding detection circuit is replaced by a quasi-peak detection circuit. The Option 02 also contains the intermod measurement capability of the Option 01.

The AA 501 Distortion Analyzer and the SG 505 Oscillator were designed to be used together as the heart of a state-of-the art audio analysis system. Used together, the two provide total system harmonic distortion of 0.0025% or less.

It should be noted that the automatic frequency tuning of the AA 501 does not depend upon the manual tuning of a companion oscillator. The AA 501 will automatically tune itself to its input signal whether the signal originates from an SG 505 alongside it in a TM 500 Mainframe, or from some other signal source miles away.

CHARACTERISTICS

The following electrical characteristics are common to the standard AA 501, Option 01 and Option 02 unless otherwise noted:

THD

Complete automatic Total Harmonic Distortion (THD) measurements to specified accuracy in 7 s or less.

LEVEL

Autoranging digital voltmeter displays input signal level in volts, dBm, or dB ratios.

IMD (OPTION 01, OPTION 02)

Fully automatic SMPTE, DIN, and CCIF difference frequency test measurements.

NOISE (OPTION 02)

Noise measurements to CCIR recommendation 468-2 and DIN 45402. True RMS or quasi-peak response. Total system THD+N = 0.0032% (90 dB) RMS response. Balanced input.

DISTORTION FUNCTION

Fundamental Frequency Range — 10 Hz to 100 kHz automatically tuned to input frequency.

Distortion Ranges — Auto (100%), 20%, 2%, 0.2%, and dB (autoranging).

Accuracy (Readings ≥4% of Range) — 20 Hz to 20 kHz ±1 dB, 10 Hz to 100 kHz +1, −3 dB. (Accuracy is limited by residual THD+N and filter selection.)

AA 501/SG 505 System Residual THD+N — V_{in} ≥250 mV, (all distortion, noise, and nulling error sources combined).

20 Hz to 20 kHz

≤0.0025% (−92 dB) Average Response with 80 kHz filter (standard and Option 01 only).

≤0.0032% (−90 dB) RMS Response with 80 kHz filter.

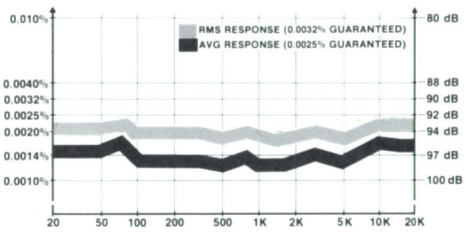
10 Hz to 50 kHz

≤0.0071% (−83 dB) RMS Response.

50 kHz to 100 kHz

≤0.010% (−80 dB) RMS Response.

TYPICAL THD+N



Typical Fundamental Rejection — At least 10 dB below specified residual THD+N or actual signal THD, whichever is greater.

Minimum Input Level — 60 mV (−22 dBm).

LEVEL FUNCTION

Modes — Volts, dBm (600 Ω), or dB ratio with push to set 0 dB reference.

Level Ranges — 200 μV full scale to 200 V full scale in ten steps, manual or autoranging.

Accuracy[*1]

Frequency	Volts	dBm or dB ratio
20 Hz to 20 kHz	±2%	±0.3 dB
10 Hz to 100 kHz[*2]	±4%	±0.5 dB

*[*1] V_{in} ≥ 100 μV, level ranging indicators extinguished.*

*[*2] On the 200 μV range, accuracy above 50 kHz is +4%, −6% (+0.5 dB, −0.7 dB).*

Bandwidth — ≥300 kHz.

Residual Noise — ≤3.0 μV (−108 dBm) with 80 kHz and 400 Hz filters.

≤1.5 μV (−114 dBm) with "A" weighting filter.

INTERMODULATION DISTORTION FUNCTION (OPT 01/02)

SMPTE and DIN Tests

Lower Frequency Range: 50 Hz to 250 Hz.

Upper Frequency Range: 3 kHz to 100 kHz.

Level Ratio Range: 1:1 to 5:1 (lower:upper).

Residual IMD: ≤0.0025% (−92 dB) for 60 Hz and 7 kHz or 250 Hz and 8 kHz, 4:1 level ratio.

CCIF Difference Frequency

Frequency Range: 4 kHz to 100 kHz.

Difference Frequency Range: 50 Hz to 1 kHz.

Residual IMD: ≤0.0018% (−95 dB) with 14 kHz and 15 kHz.

Minimum Input Level: 60 mV (−22 dBm).

Accuracy — ±1 dB.

ALL FUNCTIONS

Filters

400 Hz High Pass: −3 dB at 400 Hz ±5%; at least −40 dB rejection at 60 Hz.

80 kHz Low Pass: −3 dB at 80 kHz ±5%.

30 kHz Low Pass: −3 dB at 30 kHz ±5% (standard and Option 01 only).

"A" Weighting: Meets specifications for Type 1 sound level meters (ANSI S 1.4, IEC Recommendation 179) (standard and Option 01 only).

Ext: Allows connection of external filters.

22.4 Hz to 22.4 kHz: −3 dB ±5% (Option 02 only).

CCIR WTG: CCIR Recommendation 468-2 and DIN 45405, functional only with Q-PK detector (Option 02 only).

Input Impedance — 100 kΩ ±2%, each side to ground, fully differential.

Maximum Input — 300 V pk, 200 V RMS either side to ground or differentially.

Fully protected on all ranges.

Common Mode Rejection — ≥50 dB at 50 or 60 Hz.

Typically ≥40 dB to 300 kHz.

Detection — Average or true RMS for waveforms with crest factors ≤3.

FRONT PANEL SIGNALS

Input Monitor — Provides constant amplitude version of signal applied to input. Output Voltage: 1 V RMS ±10% for input signals >50 mV. Source Impedance: 1 kΩ ±5%.

Function Output — Provides a scaled sample of selected function signal (1000 count display = 1 V RMS ±3%). Source Impedance: 1 kΩ ±5%.

Auxiliary Input — Provides input to detector circuit when Ext Filter button is depressed. Sensitivity: 1 V RMS ±3% = 1000 count display. Impedance: 100 kΩ ±5%, ac coupled.

REAR INTERFACE SIGNALS

Rear INTFC Input — Front panel selected. Same as main Input except, maximum signal input is limited to 42 V pk, 30 V RMS. (Potential crosstalk at rear interface may degrade noise and distortion on performance).

Monitor — Same as front panel Input Monitor.

Function Output — Same as front panel Function Output.

Auxiliary Input — Same as front panel Auxiliary Input.

Converter Output — Dc output of selected response converter. 1 V ±5% for 1000 count display. Source Z: 500 Ω ±5%.

dB Output — Dc output of logarithmic dB converter. 10 mV ±5% per 1 dB of display. Source Z: 1 kΩ ±5%.

Included Accessory — Instruction manual.

ORDERING INFORMATION

AA 501 Distortion Analyzer **$2,190**

Option 01 — Intermodulation Distortion ..... **+$710**

Option 02 — CCIR/DIN (Includes Option 01) ..... **+$1,080**

PRODUCT SUMMARY

The TM 500 Signal Conditioners offer unique capabilities for solving electrical measurement and analysis problems. Compact portability and plug-in flexibility allow complete lab instrumentation set-ups, within stringent space and budget limitations.

These versatile signal alteration devices are applicable to a broad range of measurement needs including: preamplification of low level signals, addition or removal of dc offset, integration, differentiation, or summing of multiple signals; impedance transformation; or amplification (to 80 V peak-to-peak).

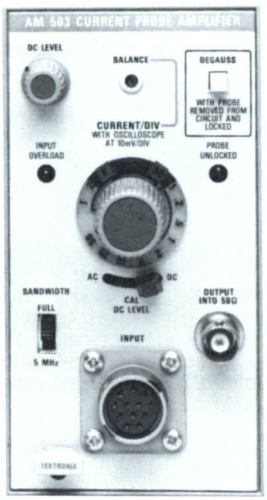
The AM 503 is specifically designed to work with the A6303/A6302 Current Probes (up to 50 MHz), and incorporates a feature that limits the bandwidth to 5 MHz, to eliminate transients or noise. An illuminated knob skirt indicates calibrated current per division.

The A6302/AM 503 and A6303/AM 503 Current Probe Systems have a wide variety of applications from SCR and power supply measurements to medical applications. These probes use inductive coupling to minimize interference with the circuit under test.

The versatile AM 502 Differential Amplifier lets you control gain, dc offset and low-frequency and high-frequency response for maximum rejection of unwanted signals. Adjustable dc offset allows high amplification even when low-level signals have a dc component of up to 1 V. High performance features of the AM 502 are a dc to 1 MHz bandwidth and 100 dB common-mode rejection ratio.

The AM 501 Operational Amplifier's output power (±40 V and ±50 mA across 800 Ω loads) is more than adequate for most electronic and electro-mechanical applications. This high-output unit has front panel connectors that let you change configurations by selecting feedback components. The AM 501 is easily set up for differentation, integration, summing and impedance transformation problems.

AM 503



Current Probe Amplifier

AM 503

Displays Current Signals on an Oscilloscope

Current Range, Maximum Current, and Bandwidth Determined by the Probe Used

The AM 503 Current Probe Amplifier allows display of current on any oscilloscope with 10 mV/div sensitivity, 50 Ω or 1 MΩ input, and (for performance to full bandwidth specifications) at least 75 MHz when using the A6302 or 50 MHz when using the A6303. The amplifier attenuator is calibrated in 12 steps with a 1-2-5 sequence, and the knob-skirt is illuminated to indicate current per division. The current range, maximum current rating, and bandwidth are determined by the particular probe in use. Bandwidth can be set to Full (where it is limited by the probe in use) or to 5 MHz. Coupling may be switch selected to ac or dc. Ac coupling offers a convenient means of measuring low-amplitude ac signals on a high-level dc current. A front-panel indicator warns of input current overload.

CHARACTERISTICS

The AM 503 characteristics when used with the A6302 or A6303 Current Probes.

Maximum Input Current — 20 A (dc + peak ac) for A6302. 100 A (dc + peak ac) for A6303.

Maximum Voltage for Current Under Test (Bare Conductor) — 500 V (dc + peak ac) for A6302. 700 V (dc + peak ac) for A6303.

Bandwidth (−3 dB) — Dc to at least 50 MHz with A6302. Dc to at least 15 MHz with A6303.

Risetime (Full Bandwidth) — 7 ns or less with A6302. 23 ns or less with A6303.

Deflection Factor — 1 mA/div to 5 A/div for A6302. 20 mA/div to 50 A/div for A6303. In a 1-2-5 sequence for both probes.

Attenuator Accuracy — Within 3% of indicated Current/Div for both probes.

INCLUDED ACCESSORIES

50 Ω cable with BNC (012-0057-01); 50 Ω terminator (011-0049-01); instruction manual.

Order AM 503 Current Probe Amplifier **$1,060**

A6303 Current Probe

Ac and Dc Current Measurements to 100 A

Dc to 15 MHz Bandwidth

Peak Pulse Measurements to 500 A

Ac or Dc Coupling

1 Inch by 0.830 Inch Jaw Opening

One-Hand Operation

This clamp-around probe satisfies requirements for current measurements to 100 A from dc to 15 MHz. Equipped with a convenient pistol grip, the A6303 can easily be clamped to cables up to 0.830 in. Other measurement parameters of the probe include: 100 A continuous and 500 A peak.

By combining an oscilloscope, like the SC 504, with the A6303/AM 503 Current Probe Amplifier in a TM 500/TM 5000 Mainframe you will have a convenient and compact high current amplification/-measurement system.

Included Accessories — Carrying case (016-0622-00); instruction manual.

Order A6303 Current Probe **$1,010**

A6302 Current Probe

1 mA to 20 A Current Measurement Range

50 A Peak Pulse Measurements

Dc to 50 MHz Bandwidth

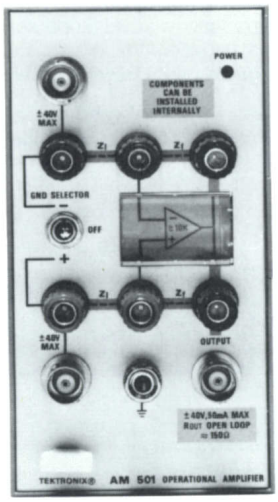
When a A6302 Current Probe is used with the AM 503 Current Probe Amplifier, the current range is from 1 mA to 20 A. Maximum current is 20 A (dc + peak ac). Peak pulse maximum is 50 A, not to exceed a product of 100 A μs. The probe operates through inductive coupling with no electrical contact. A flick of your forefinger operates the sliding jaw in the insulated probe tip. Just put the probe tip around the conductor under test for immediate current readings.

INCLUDED ACCESSORIES

Five inch ground lead (175-0124-01); three inch ground lead (175-0263-01); two alligator clips (344-0046-00); instruction manual.

Order A6302 Current Probe **$530**

AM 501



Operational Amplifier

AM 501

±40 V, 50 mA Output

Open Loop Gain 10,000

50 V/μs Slew Rate

Symmetrical Differential Design

The AM 501 Operational Amplifier features high input impedance (FET), high slew rate, a wide range of input and output voltage, and high output current. Applications include: amplification; impedance transformation; integration; differentiation and summing. It is well-suited as a post-amplifier or offset-generator for signal sources, including the TM 500 modules. Components may be added externally or internally making it ideal for teaching operational amplifier theory.

CHARACTERISTICS

OPERATIONAL AMPLIFIER

Open Loop Gain — At least 10,000 at 60 Hz into 800 Ω load.

Unity Gain Bandwidth — At least 5 MHz into 800 Ω load.

Common-Mode Rejection Ratio — Typically >20,000 to 1 at 60 Hz for common-mode signals up to ±40 V.

Slew Rate — At least 50 V/μs into an 800 Ω load.

INPUT

Input Bias Current — Typically <500 pA at 25°C, <2 nA at 50°C.

Drift — <100 μV/°C.

Noise — <10 μV RMS.

Maximum Differential Input Voltage — 80 V.

OUTPUT

Voltage Range — At least ±40 V into 2 kΩ.

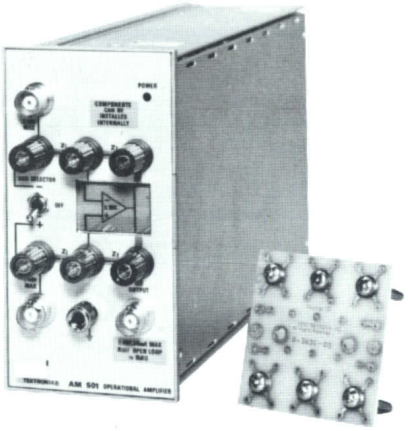
Current Limit — At least ±50 mA.

Open Loop Output R — ≈150 Ω.

Included Accessory — Instruction manual.

Order AM 501 Operational Amplifier **$595**

AM 501 Accessory

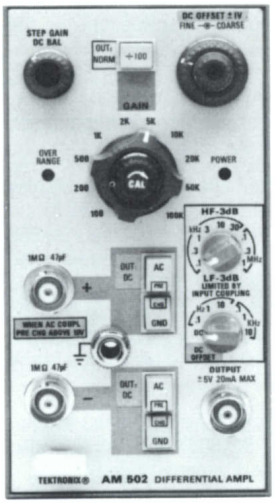


AM 501 Auxiliary Circuit Board Kit

The AM 501 Auxiliary Circuit Board Kit attaches to the input and output terminal plugs on the front of the AM 501 Operational Amplifier. The kit is a pc board that has six terminal studs for attachment to the amplifier's banana jacks and is approximately 2.5 inches square. This permits the designer to build a circuit of resistors, capacitors, and other components for use in conjunction with the AM 501's input, output, or feedback circuits. With several boards, the AM 501 Op Amp circuit can be changed instantly in configuration from integrator to differentiator to amplifier and does not interfere with the other connectors on the face of the AM 501.

Order 013-0146-00 ..... **$22**

AM 502



Differential Amplifier

AM 502

1 to 100,000 Gain

100 dB CMRR

Selectable Upper and Lower −3 dB Points

Dc to 1 MHz Maximum Bandwith

Adjustable Dc Offset

The AM 502 Differential Amplifier features wide bandwidth, high CMRR, and selectable calibrated gain and filtering. Well-suited for general purpose or laboratory work, it can drive oscilloscopes, monitors, chart recorders, displays, or processing devices. In the unity gain mode, it can be used as a signal conditioner. Input dc offsetting to ±1 V is provided.

CHARACTERISTICS

AMPLIFIER

Gain — 100 to 100,000; 1-2-5 sequence; accurate within 2%. 1X gain obtained by 100X attenuation.

HF −3 dB POINT — Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. Upper −3 dB point reduces to 500 kHz at 50 k gain; 250 kHz at 100 k gain.

LF −3 dB POINT — Selectable in 6 steps from 0.1 Hz to 10 kHz; ac coupling limits −3 dB point to 2 Hz or less.

Variable Dc Offset — At least ±1 V.

Common-Mode Rejection Ratio — Normal Mode: At least 100 dB, dc to 50 kHz. ÷ 100 Mode: At least 50 dB, dc to 50 kHz.

Maximum Input Voltage — Normal Mode Dc Coupled: 15 V (dc + peak ac). ÷ 100 Mode Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V (dc + peak ac) with coupling capacitor precharged.

Input R and C — 1 MΩ paralleled by ≈47 pF. Input impedance can be increased to a FET input via a simple internal jumper change.

Maximum Voltage Drift — 100 μV/°C referred to input Norm mode.

Input Gate Current — ±100 pA for T ≤30°C.

Maximum Noise — ≤25 μV or less (tangentially measured) referred to input Norm mode.

OUTPUT

Maximum Output — ±5 V, ±20 mA, output resistance is 5 Ω or less.

Minimum Load Impedance — 250 Ω

Over Range — Front-panel lamp indicates most over-range conditions.

Included Accessory — Instruction manual.

Order AM 502 Differential Amplifier ... **$1,185**

For compatible accessories — refer to page 437.

PRODUCT SUMMARY

The ubiquitous cathode-ray oscilloscope is the world's most useful and versatile electronics test and measurement instrument. Tektronix, long identified with the oscilloscope, could hardly develop the TM 500 line of modular instrumentation without including CRT display capability.

Four choices of performance level and display size are available to add waveform display to the digital measurement capability of the TM 500 digital multimeters and counters, ranging from the high-performance, dual-trace, 80 MHz SC 504 to the single-trace, single-width, 5 MHz SC 501. The 15 MHz SC 502 adds moderate dual-trace performance to the line, and the 10 MHz, dual-trace SC 503 adds CRT storage capability.

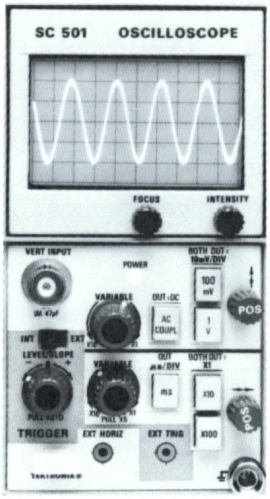
All of the oscilloscopes feature automatic triggering, and the SC 504, SC 503, and SC 502 also provide trigger view and variable trigger holdoff. All of the oscilloscopes have provisions to permit instrument-to-instrument rear interfacing within a mainframe and to external devices of a test system.

With a compact TM 500 oscilloscope and a multicompartment TM 500 mainframe, it is now possible to carry an oscilloscope and companion instruments to and from a test site in one convenient package.

TM 500 OSCILLOSCOPE SELECTION GUIDE

	SC 504	SC 503	SC 502	SC 501
Number of Channels	2	2	2	1
Bandwidth (MHz)	80	10	15	5
Highest Sensitivity (mV/Div)	5	1	1	10
Fastest Sweep Rate (nS/Div)	5	50	20	200
Storage	No	Yes	No	No

SC 501



5 MHz Oscilloscope

SC 501

5 MHz Bandwidth

Single Compartment Size

6.4 cm (2.5 inches) CRT

Versatile Operating Features

The SC 501 is a single-channel, 5 MHz plug-in unit oscilloscope with a 2.5 inch CRT display that occupies a single TM 500 Series plug-in compartment. Oscilloscope capability significantly enhances the application range of the multifunctional TM 500 Series Test and Measurement Instruments.

With the SC 501 a multitude of versatile test systems may be structured from the TM 500 Series to suit specific needs for time and frequency response, modulating waveforms, power for devices under test, stimulus and response studies and voltage, current, and temperature measurements. Since the SC 501 fits any TM 500 or TM 5000 mainframe, it can be used on the bench, in a rack, or on the road. The single-channel SC 501 has a calibrated vertical deflection range from 10 mV/div to 1 V/div, selectable in decade steps. A variable control extends this range to at least 10 V/div.

Calibrated sweep rates are selected by push-button logic in decade steps from 1 μs/div to 100 ms/div. A variable control extends the slowest sweep rate to at least 1 s/div and a fixed magnifier extends the fastest sweep rate to 200 ns/div.

A 0 V to 10 V ramp for all sweep rates (excluding the X5 magnification) is provided at a rear interface connector. This capability may be used for many auxiliary functions, for example sweeping a voltage-controlled frequency oscillator.

The triggering circuits allow stable triggering from either internal or external sources. An Autotriggering mode and manual Level/Slope selection is combined in a single control. It is useful above 10 Hz and provides a bright baseline at all sweep rates.

For X-Y operation an internal switch converts the horizontal deflection system of the SC 501 to an external horizontal amplifier which is internally calibrated for 100 mV/div deflection factor with a bandwidth of 100 kHz.

CHARACTERISTICS

VERTICAL DEFLECTION

Bandwidth — Dc to >5 MHz.

Deflection Factors — 10 mV/div, 100 mV/div, and 1 V/div. Accuracy, within 3%. Uncalibrated (variable) range, continuously variable between steps (10:1) and to at least 10 V/div.

Input Coupling — Ac or dc.

Input Impedance — 1 MΩ paralleled by 47 pF.

Maximum Input Voltage — 350 V (dc + peak ac).

HORIZONTAL DEFLECTION

Time Base — Calibrated Sweep Rates: 1 μs/div to 100 ms/div in decade steps. Uncalibrated (Variable) Range: Extends slowest calibrated rate to ≥1 s/div. X5 Magnifier (Fixed): Extends fastest calibrated sweep rate to 200 ns/div. Accuracy (Over Center 8 Div): ≥5% for all sweep rates. Linearity (Any Two Div Portion Within Center Eight Div): ≥5%.

External Horizontal Amplifier — Bandwidth: Dc to 100 kHz. Input Impedance: ≥100 kΩ paralleled by 25 pF. Maximum Input Voltage: ±3 V.

TRIGGER

Normal Trigger Sensitivity (Trigger Level/Slope In) — Internal: Dc coupled, 0.4 major div of deflection at dc; increasing to 1.0 major div of deflection at 5 MHz. External: Dc coupled, 1 V minimum to 5 V maximum from dc to 5 MHz. External Trigger Input Impedance: 22 kΩ paralleled by ≈150 pF.

Auto (Trigger Level/Slope Out) — Sweep free-runs without trigger signal, or for trigger repetition rates below 10 Hz.

CRT

Phosphor — GH (P31) is standard.

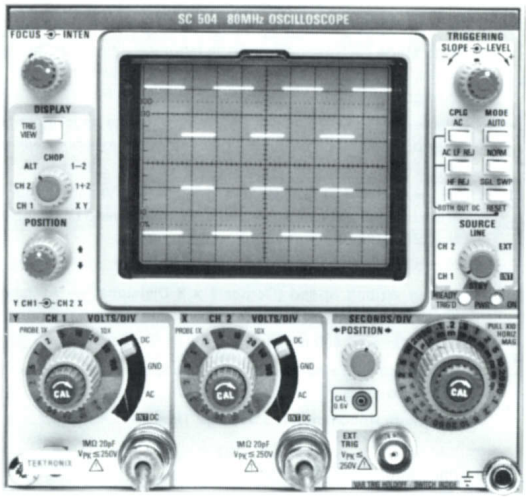
Graticule — 6 x 10 div (0.203 in/div).

Included Accessory — Instruction manual.

Order SC 501 5 MHz Oscilloscope **$1,280**

Compatible accessories begin on page 437.

SC 504



80 MHz Oscillosope

SC 504

80 MHz Bandwidth

5 mV/div Maximum Sensitivity

5 ns/div Maximum Calibrated Sweep Rate

Enhanced Automatic Triggering

True X-Y Capability

Switchable Rear Interface Capability

The SC 504 is a general purpose, dual-trace, non-delayed-sweep oscilloscope. It has a high writing speed with a maximum sensitivity of 5 mV/div, and a maximum sweep rate of 5 ns/div (with magnifier). This oscilloscope features Add (CH 1 plus CH 2), differential (CH 1 minus CH 2), and "true" X-Y modes, and also includes rear interfacing capability (switchable CH 1, CH 2 and ext trig inputs). Enhanced autotriggering, trigger view, and variable trigger holdoff make this oscilloscope very versatile and easy to use. The Tektronix P6108, P6122 and P6062B probes are recommended for use with the SC 504.

CHARACTERISTICS

VERTICAL DEFLECTION

Bandwidth at −3 dB Points — Dc to at least 80 MHz from 0°C to +35°C; dc to at least 70 MHz from +35°C to +50°C.

Risetime — 4.4 ns or less from 0°C to +35°C; 5 ns or less from +35°C to +50°C.

Ac Low Frequency Response (Lower −3 dB Points) — Without probe, 10 Hz; with 10X probe, 1 Hz.

Deflection Factors — Calibrated Range: 5 mV to 10 V/div, 11 steps in a 1-2-5 sequence.

Accuracy — ±2%, +15°C to +35°C; ±3%, 0°C to +50°C. Uncalibrated Range: Continuously variable between calibrated steps. At least 2.5:1 range. Extends maximum deflection factors to at least 25 V/div.

Modes — CH 1, CH 2, Alt., Chop, CH 1 minus CH 2, CH 1 plus CH 2, X-Y. Chop rate at least 250 kHz.

Input R and C — 1 MΩ ±1% paralleled by ≈20 pF.

Maximum Input Voltage — 250 V (dc + peak ac), 500 V p-p ac at 1 kHz or less.

Common-Mode Rejection Ratios — At least 50:1 up to 1 MHz, and 10:1 from 1 MHz to 10 MHz when using the same attenuator settings; common-mode signal 5 divisions or less.

Position Range — ±6 division.

Delay Line — Permits viewing leading edge of displayed waveform.

Calibrator — 0.6 V, ±1%, ≈1 kHz frequency.

HORIZONTAL DEFLECTION

Sweep Generator — Calibrated Sweep Rates: 0.2 s to 50 ns/div, 21 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 5 ns/div. Uncalibrated (Variable) Range: The Cal (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 0.5 s/div.

Sweep Rate Accuracy — Measured over center 8 divisions, excluding first 50 ns and all after the first 100 divisions of magnified sweep. Derate accuracies by an additional 1% from 0°C to +15°C, and +35°C to +50°C.

+15°C to +35°C	X1	X10
20 ms/div to 0.2 μs/div	±2%	±3%
0.2 s/div to 50 ms/div	±3%	±4%
0.1 μs/div to 50 ns/div	±3%	±4%

X-Y Mode — Bandwidth: Dc to at least 2 MHz. Deflection factor, selected by CH 2 controls and horizontal mag X1, X10 with 5% accuracy. X and Y amplifier phase difference, less than 3° at 50 kHz or less. Input parameters same as CH 2.

TRIGGER

Trigger Modes — Auto, Norm, and Sgl Swp.

Enhanced Auto Trigger — The trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

Trigger Sources — CH 1, CH 2, Line, Ext, Int.

Trigger Coupling — Ac, ac LF Rej, ac HF Rej, dc.

Trigger Sensitivity — Minimum p-p signal required.

Coupling	Source	Dc to 30 MHz	30 MHz to 80 MHz
Dc	CH 1, CH 2 External Interface	0.4 div 60 mV Typically 50 mV	1.0 div 150 mV Typically 100 mV to 50 MHz
Ac	Requirements increase below ≈50 kHz		
Ac LF Rej	Requirements increase below ≈10 kHz		
HF Rej	Requirements increase above ≈50 kHz		

External Triggering Level Range — ⩾ ±1.4 V.

External Triggering Input — Input R and C: 1 MΩ ±10% paralleled by approximately 24 pF. Maximum Input Voltage: 250 V (dc + peak ac); 250 V p-p at 1 kHz or less.

Auto Mode — Sweep free runs in the absence of a triggering signal. Trigger Level range is reduced to approximately the p-p range of the triggering signal.

Single Sweep — Triggering requirements are as for normal sweep. When triggered, sweep generator produces one sweep only.

Trigger Holdoff — At least 20 to 1 range. The Variable control is internally selectable between the Variable Sweep or Variable Holdoff functions.

CRT

Phosphor — GH (P31) is standard.

Acceleration Potential — ≈12 kV.

Graticule — Scale, 8 x 10 div with 0.25 in/div internal graticule lines.

REAR INTERFACE

CH 1 and CH 2 Vertical Inputs — Selected by CH 1 and CH 2 coupling in Int (interface) position. Input Impedance: 50 Ω. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈60 pF.

Trigger Input — Selected by Trigger Source switch in Int (interface) position. Input Impedance: 50 Ω when selected, 25 Ω when not selected. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈40 pF.

Z-Axis Input — Input Impedance: ≈1.5 kΩ. +5 V turns beam On from Off condition, −5 V turns beam Off from On condition.

Channel 1 Output — At least 50 mV/div. Bandwidth: At least 30 MHz. Output Impedance: <50 Ω.

Ramp Output — 0 to +10 V ramp. Output resistance ≈500 Ω.

Included Accessory — Instruction manual.

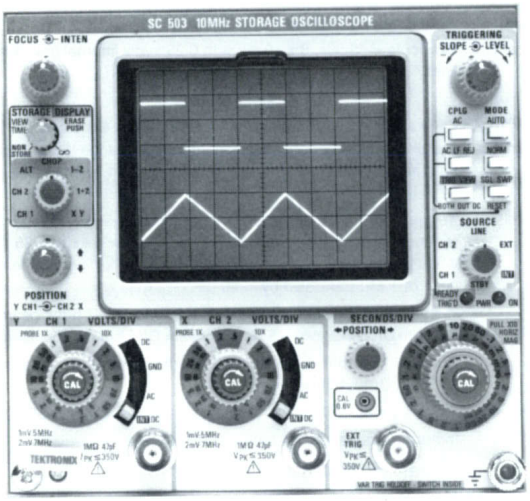
Order SC 504 80 MHz Oscilloscope **$3,200**

RECOMMENDED PROBES

P6101 1X, P6122 10X, P6108 10X, P6062B 1X/10X. See pages 451, 452 and 455.

Compatible accessories begin on page 421.

SC503



10 MHz Dual Trace Storage Oscilloscope

SC 503

10 MHz Bandwidth

Bistable Storage Autoerase

Trigger View

Variable Holdoff

Switchable Front/Rear X and Y Inputs

Rear Z-Axis Input

True X-Y Capability

The SC 503 is a nondelayed sweep, general purpose storage oscilloscope which can be used to store and display waveforms after the input signal is removed. This feature is particularly useful when measuring slow repetition rates or single-shot signals, important in the biomedical and mechanical measurements fields. Low frequency signals at heart or respiration rates can be stored for detailed analysis. In the mechanical measurements field the SC 503 can "freeze" fast or transient signals from transducers, which is especially useful in pressure-and velocity-versus-time analysis and shock testing.

Other important storage applications of the SC 503 include measurements of signals in computer peripherals, communication terminals and industrial control systems.

The SC 503 also features an auto-erase mode that erases the stored signal and automatically retriggers the oscilloscope, and X-Y capability. The X-Y capability allows creation of Lissajous patterns in many cause and effect testing relationships including: acoustic speech testing, nerve potential testing, and optical stimulus response testing. The Tektronix P6108 and P6062B probes are recommended for use with the SC 503.

CHARACTERISTICS

VERTICAL DEFLECTION

Bandwidth at −3 dB Points — Dc to at least 10 MHz, (5 mV/div to 20 mV/div); dc to at least 7 MHz (2 mV/div), dc to at least 5 MHz (1 mV/div).

Risetime — 5 mV to 20 V/div, typically 35 ns or less.

Ac Low-Frequency Response (Lower −3 dB Points) — Without probe, 10 Hz; with 10X probe 1 Hz.

Deflection Factors — Calibrated Range: 1 mV/div to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy: 5 mV to 20 V/div (+15°C to +35°C) ±3%, 1 mV/div and 2 mV/div ±5%; (derate accuracy by additional 1% for 0°C to +50°C). Uncalibrated Range: At least 2.5:1 continuously variable between calibrated steps. Extends maximum uncalibrated deflection factor to at least 50 V/division.

Modes — CH 1, CH 2, Alt, Chop, CH 1 minus CH 2, CH 1 plus CH 2, X-Y. Chop rate at least 250 kHz.

Input Impedance — 1 MΩ ±1% paralleled by ≈47 pF.

Maximum Input Voltage — 350 V (dc + peak ac), 700 V p-p ac at 1 kHz or less. Above 1 kHz recommended p-p ac limit is 250 V to 10 kHz derating to 25 V above 100 kHz.

Common-Mode Rejection Ratio — At least 50:1 at 1 MHz when using same attenuator setting, in CH 1 minus CH 2 mode.

Delay Line — Permits viewing leading edge of displayed waveform.

Calibrator — 0.6 V, ±1%, ≈1 kHz frequency.

Position Range — ±6 div.

Channel Isolation — 2% or less display related crosstalk to 10 MHz.

Displayed Noise — <0.2 mV p-p at 1 mV/div.

HORIZONTAL DEFLECTION

Sweep Generator — Calibrated Sweep Rates: 2 s/div to 0.5 μs/div, 21 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 50 ns/div. Uncalibrated (variable) range provides continuously variable sweep rates, between the calibrated rates, and extends the slowest rate of at least 5 s/div.

Sweep Rate Accuracy*1

+15°C to +35°C	X1	X10
2 s/div to 0.5 s/div	±4%	±5%
0.2 s/div to 5 μs/div	±3%	±4%
2 μs/div to 0.5 μs/div	±4%	±5%

*1 *Derate accuracy by an additional 1% from 0° C to +15° C and +35° C to +50° C.*

X-Y Mode — Bandwidth: Dc to at least 500 kHz. Deflection Factor: Selected by CH 2 controls and Horizontal Mag X1, X10. Phase Difference: <3° at 50 kHz or less.

TRIGGER

Trigger Modes — Auto (enhanced), Norm, and Sgl Swp (single sweep).

Enhanced Auto Trigger — The trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

Trigger Sources — CH 1, CH 2, Line, Ext, Int (rear interface).

Trigger Coupling — Dc, ac, ac LF Rej.

Trigger Sensitivity*1 — Minimum p-p signal required.

Source	dc to 5 MHz	5 MHz to 10 MHz
CH 1, CH 2	0.4 div	1.0 div
External	60 mV	150 mV
Interface	Typically 35 mV	Typically 80 mV

*1 *With ac coupling requirements increase below ≈50 Hz. With ac LF Rej coupling requirements increase below ≈10 kHz.*

Triggering Level Range — External: At least ±1.2 V. Internal: At least −6.0 div.

External Triggering Input — Input Impedance: 1 MΩ, paralleled by ≈47 pF. Maximum Input Voltage: 350 V (dc + peak ac), 350 V p-p at 1 kHz or less. Above 1 kHz recommended p-p ac limit is 100 V to 10 kHz derating to 10 V above 100 kHz.

Auto Mode — Sweep free-runs in the absence of a triggering signal. Level control range automatically varies with the triggering signal amplitude for frequencies above 100 Hz.

Single Sweep — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only.

Trigger Holdoff — At least 20 to 1 range. The Variable control is internally selectable between the Variable Sweep or Variable Holdoff functions.

STORAGE SYSTEM

Stored Writing Speed (Center 6 x 8 Divisions) — At least 80 div/ms (50 cm/ms).

Erase Time — 400 ms to 600 ms.

Autoerase Viewing Time — Continuously variable from ≤0.5 s to ≥5 s.

Maximum Recommended Storage Time — ≈4 hours.

CRT

Phosphor — GX (P44).

CRT Graticule — 8 x 10 div., 0.25 in/div (0.64 cm/div). Internal graticule lines.

REAR INTERFACE

CH 1 and CH 2 Vertical Inputs — Selected by CH 1 and CH 2 coupling in Int (interface) position. Input Impedance: 50 Ω. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈100 pF.

Trigger Input — Selected by Trigger Source switch in Int (interface) position. Input Impedance: 50 Ω, when selected, 25 Ω when not selected. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈60 pF.

Z-Axis Input — Input Impedance: ≈1.5 kΩ. +5 V turns beam On from Off condition, −5 V turns beam Off from On condition.

CH 1 Output — At least 50 mV/div. Bandwidth: At least 4 MHz. Output Impedance: 50 Ω.

Ramp Output — 0 to +10 V ramp Output impedance ≈500 Ω.

Included Accessory — Instruction manual.

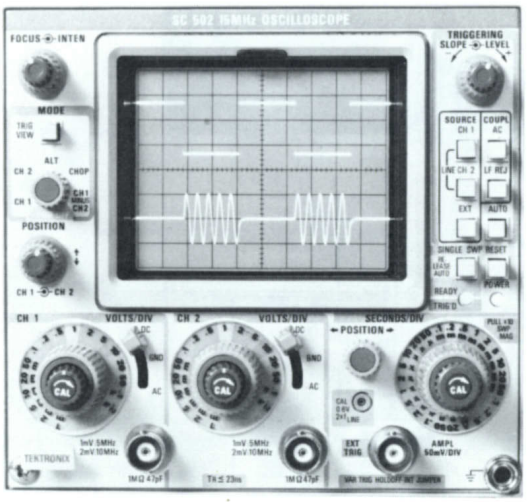
Order SC 503 10 MHz Storage Oscilloscope **$3,440**

RECOMMENDED PROBES

P6101 1X, P6108 10X, P6062B 1X/10X. See pages 452 and 455.

Compatible accessories begin on page 421.

SC 502



15 MHz Dual-Trace Oscilloscope

SC 502

15 MHz Bandwidth

Dual-Trace

20 ns/div Maximum Calibrated Sweep Rate

1 mV/div Maximum Sensitivity

Delay Line

Trigger View

Variable Trigger Hold-off

Enhanced Automatic Triggering

The SC 502 is a compact general-purpose 15 MHz dual-trace oscilloscope designed to operate in any two adjacent compartments of a TM 500 Power Module/Mainframe. It has a high writing speed, a wide range of sweep rates, a wide range of deflection factors, and versatile triggering, including trigger view and enhanced automatic triggering.

As with many Tektronix Products, the SC 502 features circuits, subcircuits, and components designed and built by Tektronix to fulfill the special design capabilities of the instrument. Among its many recommended uses, the SC 502 is intended to be a powerful tool in the field servicing of digital equipment, where it would be used in association with disk memories, key-to-tape, printers, plotters, punches, readers, and terminals. The CRT of the SC 502 offers a high writing speed as an advantage in the display of digital information, while stable, clean triggering is assured by incorporating well proven circuits. Thus, the SC 502 offers the engineer a unique combination of performance, compactness, and systems capability.

The SC 502 makes many new instrumentation systems feasible, especially in the areas of QA, production testing, maintenance, and field servicing. The rear interfacing capability of the SC 502 and all TM 500 Instrumentation suggests exceptional applicability to systems of built-in test equipment or rackmounted installations. The TM 515 Traveler Mainframe with the SC 502, forms a nucleus for sophisticated, compact field service "packages." The Tektronix P6062B and P6108 are recommended for use with the SC 502.

CHARACTERISTICS

VERTICAL DEFLECTION

Bandwidth at −3 dB Points — 5 mV to 20 V/div, dc to at least 15 MHz; 2 mV/div, dc to at least 10 MHz; 1 mV/div, dc to at least 5 MHz.

Risetime — 5 mV to 20 V/div, 23 ns or less.

Ac Low-Frequency Response (Lower −3 dB Points) — Without probe, 10 Hz; with probe (10X), 1 Hz.

Deflection Factors — Calibrated Range: 1 mV to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy: 5 mV to 20 V/div (+15°C to +35°C) within 2%, (0°C to +50°C) within 3%; 1 mV and 2 mV/div within 5%. Uncalibrated (variable) range. At least 2.5:1 range. Continuously variable between calibrated steps. Extends maximum attenuator step to at least 50 V/div.

Modes — CH 1, CH 2, Alt, Chop, CH 1 Minus CH 2. Chop rate at least 250 kHz. Triggering waveform is displayed instead of selected display when desired.

Input Impedance — 1 MΩ within 1% paralleled by ≈47 pF.

Maximum Input Voltage — 350 V (dc + peak ac), 700 V p-p at ac 1 kHz or less.

Common-Mode Rejection Ratio (CH 1 Minus CH 2 Mode) — At least 50:1 at 1 MHz when using same attenuator setting.

Channel Isolation — 2% or less display related crosstalk to 15 MHz.

Displayed Noise — ≤0.2 mV p-p at 1 mV/div.

Position Range — ±6 div.

Calibrator — Voltage, 0.6 V ±1%. Frequency, twice the power line frequency.

HORIZONTAL DEFLECTION

Sweep Generator — Calibrated Sweep Rates: 0.5 s to 0.2 μs/div, 20 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 20 ns/div. Uncalibrated (Variable) Range: The Cal (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 1.25 s/div.

Sweep Rate Accuracy — Within 3% unmagnified, 4% magnified, +15°C to +35°C. Derated by an additional 1% for 0°C to +15°C and +35°C to +50°C.

External Horizontal Amplifier — Bandwidth: Dc coupled, dc to at least 2 MHz; ac coupled <50 Hz to at least 2 MHz. Deflection Factor: 50 mV/div within 5%. X and Y Amplifier Phase Difference: <3° at 50 kHz or less. Input Impedance: 1 MΩ within 2% paralleled by ≈47 pF. Maximum Input Voltage: 350 V (dc + peak ac); 350 V p-p at 1 kHz or less.

TRIGGER

Enhanced Automatic Triggering — In the automatic mode, the trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

Trigger Modes — Auto (enhanced), Normal (auto button out), Single Sweep.

Trigger Sources — CH 1, CH 2, Line Ext.

Trigger Coupling — Dc, ac, ac LF Rej.

Trigger Sensitivity[*1]

Source	dc to 5 MHz	5 MHz to 15 MHz
CH 1, CH 2	0.4 div	1.0 div
External	60 mV	150 mV

*[*1] Minimum p-p signal required.*

With ac coupling requirements increase below ≈50 Hz. Ac LF Rej coupling requirements increase below ≈5 kHz.

Triggering Level Range — Internal: At least ±8 division. External: At least ±1.2 V.

External Triggering Input — Input Impedance: 1 MΩ within 2% paralleled by ≈47 pF. Maximum Input Voltage: 350 V (dc + peak ac); 350 V p-p ac at 1 kHz or less.

Auto Mode — Sweep free-runs in the absence of a triggering signal. Trigger Level range is reduced to approximately the p-p range of the triggering signal.

Single Sweep — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only. Auto push button must be in the Out position for operation and for setting triggering controls.

Trigger Holdoff — At least 20 to 1 range. The Variable control is internally selectable between the Variable Sweep or Variable Holdoff functions.

CRT

Phosphor — GH (P31) is standard.

Deflection — Electrostatic.

Acceleration Potential — ≈12 kV.

Graticule — Scale, 8 x 10 division with 0.25 in/div internal graticule lines.

Included Accessory — Instruction manual.

Order SC 502 15 MHz Oscilloscope **$2,340**

RECOMMENDED PROBES

P6101 1X, P6108 10X, P6062B 1X/10X. See pages 452 and 455.

Compatible accessories begin on page 421.

PRODUCT SUMMARY

The CG 5001 is the computerized solution to large-scale scope calibration needs. The CG 5001 can be used as part of a computer-based system to calibrate and verify all major oscilloscope parameters, and is specifically designed for use where many oscilloscopes are maintained. Its programmability, combined with state-of-the-art performance, helps to minimize calibration lab labor while maximizing accuracy of verification checks.

In addition to the CG 5001, TM 500 offers a complete set of calibration instruments that can be configured into a portable test set for in-field oscilloscope service and calibration. These TM 500 Oscilloscope Calibration instruments offer the widest range of standard amplitude squarewaves, fastest risetimes, lowest aberrations, fastest time marks and widest frequency range of leveled sinewaves available today.

The TG 501 Time Mark Generator provides crystal-controlled time marks from 5 s to 1 ns, plus a variable mode of operation which allows you to read the oscilloscope's timing error directly in percent from the digital display.

The PG 506 Calibration Generator provides clean, fast-rise squarewaves for checking oscilloscope transient response and calibrated-amplitude squarewaves for checking and setting the vertical amplifier gain of the oscilloscope. Like the TG 501, the PG 506 has a variable mode of operation which allows you to read the oscilloscope's calibration error directly in percent from its digital display.

The SG 503 and SG 504 generators provide leveled sinewaves for bandwidth checks (−3 dB points) and triggering performance checks. The SG 503 is a general-purpose leveled sinewave oscillator providing variable output from 250 kHz to 250 MHz. The SG 504 provides a leveled sinewave output that is variable from 245 MHz to 1050 MHz in two bands. The SG 502 Oscillator benefits calibration applications where verification of low frequency rolloff in ac modes and performance measurement of low-frequency-reject triggering modes is required.

OSCILLOSCOPE CALIBRATION PRODUCT GUIDE

	Primary Functions	Secondary Functions
CG 5001 Programmable Calibration Generator	Amplitude Calibration 40 μV to 200 V Time Base Calibration 0.4 ns to 5 s	Testing risetime and transient response, attenuator compensation, oscilloscope nonlinearity
PG 506 Calibration Generator	Amplitude Calibration 200 μV to 100 V	Testing risetime and transient response, attenuator compensation
TG 501 Time Mark Generator	Time Base Calibration 1 ns to 5 s	Testing oscilloscope nonlinearity
SG 503 Signal Generator	Bandwidth Calibration 250 kHz to 250 MHz	General leveled RF signal source
SG 504 Signal Generator	Bandwidth Calibration 245 MHz to 1050 MHz	General leveled RF signal source with frequency modulation capability

CG 5001

Programmable Oscilloscope Calibration Generator

GPIB IEEE-488

CG 5001

The CG 5001 is designed to support other products which comply with IEEE Standard 488-1978.

The Tektronix CG 5001 Programmable Oscilloscope Calibration Generator is a microprocessor-based generator that can be used as part of a computerized system for the calibration and verification of major oscilloscope parameters, including:

Vertical Gain

Horizontal Timing and Gain

Vertical Bandwidth/Pulse Characteristics

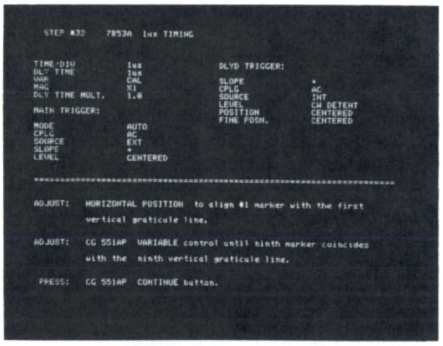
Probe Accuracy and Compensation

Current Probe Accuracy

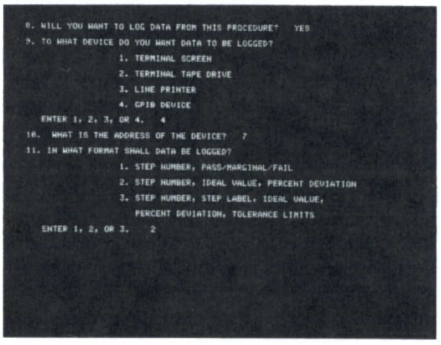
Calibrator Output Accuracy

The CG 5001's front panel features a wide range of functions, many of which represent a new state-of-the-art in calibration performance. All these functions are programmable by a controller via the GPIB (General Purpose Interface Bus). A "Learn" mode allows any manually-set function or range to be acquired by a controller. Subsequent use of the resulting program requires a minimum of operator skill and makes data logging an automatic operation.

This computer-assisted test and calibration system can provide step-by-step instructions to the operator, thus significantly reducing the skill level required.



Instruction to operator on CRT screen of 4052A Graphics Computing Controller



4052A Graphics Computer Controller showing the development of a typical calibration procedure using the ScopeCal Procedure Development Aid program

Many of the calibration and test steps previously performed by the operator can now be transferred to a computer which executes them in a consistent and error-free manner. To calibrate a particular oscilloscope, the computer's program can send control-setting information to the CG 5001, which then sends the appropriate calibration signals to the oscilloscope. At the same time, a series of operator instructions can be placed on a terminal to automatically coordinate the operator with the calibration signals being

sent from the CG 5001. The operator follows these instructions to make the necessary settings of the oscilloscope controls as the calibration or test procedure progresses. The CG 5001 returns error or deviation information to the controller, where it can be compared with preprogrammed reference values for the oscilloscope. A permanent record of the entire maintenance procedure can be stored by the controller and can be printed via peripherals such as a hard copy unit or line printer. Throughout the process, all calibration settings are determined by the computer's program. All front panel settings on the oscilloscope are specified in detail for the operator. Calculations of error percentages are performed automatically.

To develop the specific software to test and calibrate different oscilloscopes, Tektronix has designed the CG 5001 ScopeCal Procedure Development Aid program (SCPDA). This program assumes you are not familiar with programming. To incorporate the calibrator's knowledge into the system software, the (SCPDA) program uses two simplified techniques. First is a series of questions that appear on the controller's CRT. The calibrator's answers to these questions form the foundation for the software that will eventually run the system. Second is the CG 5001's "Learn" mode, which allows the calibrator to set functions and ranges using the CG 5001's front panel controls (as would have been done on older generations of manually-operated calibration generators), and have these entries automatically transferred to the controller for use in forming the program. Once the calibrator has completed interacting with the ScopeCal Procedure Development Aid program, all the acquired information is automatically converted into a simpler program format that will govern the system's operation when a less experienced operator is using it. This operator-oriented program will take care of all the CG 5001's settings, while giving the operator a step-by-step description of any settings that must be made on the oscilloscope. It will also accept data from the CG 5001 or the controller keyboard.

The CG 5001 is designed to greatly reduce your maintenance costs. Built-in self test routines and hardware check the operation of all major circuits each time the power is turned on.

Modular construction means that all circuit boards unplug (except the Main Interconnect) for easy exchange if service is required. A signature analysis mode is included to facilitate troubleshooting of the digital portion of the instrument.

CHARACTERISTICS

VOLTAGE (AMPLITUDE MODE)

The standard voltage is used to calibrate vertical display accuracy.

Range — 40 μV to 200 V (1-2-5 steps with multiplier).
Multipliers — 1,2,3,4,5,6,8,10 divisions.
Polarity — Positive from ground.
Accuracy — +0.25% ±1 μV.
Frequency — 40 mV to 80 mV: 10 Hz to 100 kHz. 100 mV to 10 V: dc or 10 Hz to 100 kHz. 12 V to 200 V: dc or 10 Hz to 10 kHz.
Variable Range — ±9.9%.

CURRENT (AMPLITUDE MODE)

The standard current is used to calibrate current probes.

Range — 1 mA to 100 mA (1-2-5 sequence).
Multipliers — 1,2,3,4,5,6,8,10.
Accuracy — ±0.25% ±2 μA.
Frequency — Dc or 10 Hz to 1 MHz (decade steps).
Droop — ≤1%.
Variable Range — ±9.9%.

LOW EDGE (AMPLITUDE MODE)

The Low Distortion Pulse obtained in this mode is used to test oscilloscope input amplifier and attenuator compensation.

Range — 20 mV to 1 V p-p (50 Ω load only) (1-2-5 steps with multipliers).
Multipliers — 1,2,3,4,5,6,8,10.
Polarity — Positive or negative transitions to ground.
Risetime (Falltime) — ≤1.3 ns.
Abberrations — ±2%.
Long Term Flatness — ±0.5% after first 10 ns.
Frequency — 10 Hz to 1 MHz (decade steps).
Variable Amplitude Range — > ±9.9% from nominal.

HIGH EDGE (AMPLITUDE MODE)

The Low Distortion Pulse obtained in this mode is used to test oscilloscope input amplifier and attenuator compensation.

Range — 1.2 V to 100 V ≥1 MΩ load (1-2-5 steps with multipliers).
Polarity — Positive transition only (negative voltage to ground).
Risetime — <100 ns.
Aberrations — ±2% of squarewave amplitude.
Long Term Flatness — ±0.5% after first 500 ns.
Frequency — 10 Hz to 100 kHz (decade steps).
Variable Amplitude Range — > ±9.9% from nominal.

MARKERS (TIMING MODE)

The markers obtained in this mode are used to calibrate oscilloscope time bases.

Range — 10 ns to 5 s (1-2-5 steps).
X10 Magnifier — Increase marker rate by a factor of ten (0.1 μs to 5 s range).
Accuracy — ±0.01% (optional TCXO ±0.0003%).
Amplitude — 1 V minimum into 50 Ω.
Variable Range — ±9.9%.

SLEWED EDGE (TIMING MODE)

Slewed Edges are used to calibrate the very fastest ranges found on oscilloscope time bases.

Range — 0.4 ns to 100 ns (1-2-5 steps plus 0.4 ns).
X10 Magnifier — Increases Slewed Edge rate by a factor of ten (5 ns to 100 ns range).
Accuracy — ±0.01% (Optional TCXO ±0.0003%).
Edge Position Uncertainty — ±40 ps.
Amplitude — >1 V into 50 Ω.
Variable Range — ±9.9%.

TRIGGER OUTPUT

The oscilloscope under test is normally triggered externally from this source.

Output Amplitude — 1 V minimum into 50 Ω.
Trigger Rate (Marker Mode) — Normal: Slaved to marker rate from 100 ns to 5 s; remains at 100 ns for faster markers. Divided by 10: Reduces normal trigger rate by a factor of ten. Divided by 100: Reduces normal trigger rate by a factor of one hundred.
Slewed Edge Mode — One trigger per slewed edge.
All Other Modes — Normal: Slaved to output frequency. Divided by 10: One-tenth output frequency. Divided by 100: One-hundredth output frequency.

TIMING REFERENCE OUTPUT

EXTERNAL TIMING REFERENCE

Input Frequency — Any integral multiple of 1 MHz up to 5 MHz.
Required Accuracy — ±0.001%.
Input Amplitude — 1 V to 10 V RMS.
Input Resistance — 10 kΩ (nominal).

ENVIRONMENTAL

Meets or exceeds MIL-T-28800B, Class 5 requirements.

Temperature — Operating: 0°C to +50°C. Nonoperating: −20°C to +65°C.
Relative Humidity — 90% to 95% at +50°C for 5 days.
Altitude — Operating: 4500 m (15,000 ft). Nonoperating: 15 240 m (50,000 ft).
Vibration — Operating: Displacement (p-p), 0.015 inch. Vibration Frequency: 10 Hz to 55 Hz. Total time: 75 minutes.
Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration, 3 shocks in each direction along 3 major axes; total shocks, 18.
Bench Handling — Operating: 45° 4 inches or point of balance, whichever occurs first.

PHYSICAL CHARACTERISTICS*1

Dimensions	mm	in
Width	203	8.0
Height	124	4.9
Depth	305	12.0
Weights	**kg**	**lb**
Standard	3.9	8.5
Option 01	4.0	8.7

*1 *Maximum Overall Dimensions (triple compartment plug-in).*

PULSE HEAD (STANDARD ACCESSORY)

FAST EDGE (AMPLITUDE MODE)

The Pulse Head is used to generate fast rise, low distortion pulses for testing higher bandwidth vertical amplifiers.

Amplitude — 1.1 V peak ±5% into 50 Ω.
Adjustable Range — ±10%.
Risetime — ≤200 ps.
Polarity — Positive or negative transitions from ground.
Aberrations — ±3% of pulse amplitude; not to exceed 4% p-p for adjacent peaks.
Frequency — 100 Hz to 100 kHz (decade steps).

INCLUDED ACCESSORIES

Output cable assembly (012-0884-00); pulse head (015-0311-01); instruction manual.

MAINFRAMES

CG 5001 requires either a TM 5003 or TM 5006. The CG 551AP is a TM 500 version of the CG 5001 and requires a TM 506 Mod JB, TM 515 Mod UB or RTM 506 Mod JB. The CG 5001 is not compatible with TM 500 power module mainframes.

ORDERING INFORMATION

CG 5001 Programmable Calibration Generator **$13,630**

CG 551AP Programmable Calibration Generator **$13,630**

Option 01 — Adds High Accuracy Time Base (TCXO) CG 5001/CG 551AP. ..... **+$615**

Option 02 — Deletes Pulse Head CG 5001/CG 551AP. ..... **−$1,100**

Utility Software **$150**

Refer to page 330 for description and ordering information.

OPTIONAL ACCESSORIES

Comparator Head — Used to calibrate built-in oscilloscope calibrators against the signals available from the CG 5001. Both the oscilloscope calibrator and CG 5001 standard amplitude signals are applied to the Comparator Head and simultaneously displayed on the oscilloscope CRT. The CG 5001 signals are then varied to obtain congruent displays. Errors are then displayed on the CG 5001 readout.
Order 015-0310-01 ..... **$500**

Remote Variable — Permits remote operation of the following front panel controls: Units/Div, Variable-Fixed Button, Continue Pushbutton and the VAR. Order 015-0309-01 ..... **$375**

Pulse Head — Order 015-0311-01 ..... **$1,400**
(When purchased separately.)

4052A — Graphics Computing Controller (32 kbytes memory). (See page 129.) **$9,900**

Option 10 — Printer Interface ..... **+$550**

Blank 4052A Tape — Order 119-0680-01 (box of 5) **$120**
Order 119-0680-00 (One each) **$30**

4632 — Hard Copy Unit (See page 134) **$6,050**

Option 01 — Copy Counter ..... **+$120**

Paper — Carton of four rolls. Order 006-1603-01 ..... **$320**

Paper, Carton of 2,500 sheets,
Order 002-0262-01 ..... **$60**

GPIB Cable, 2 meter Cable,
Order 012-0630-01 ..... **$75**

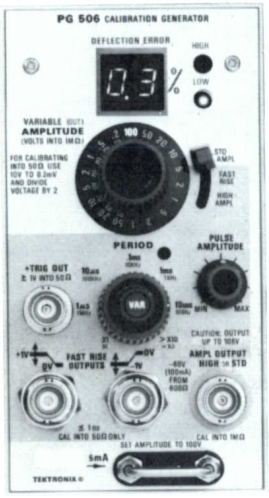
SCPDA I (ScopeCal Procedure Development Aid and 465B Verification Program) **$100**

Rigid Circuit Board Extender
Order 067-0975-00 ..... **$85**

Flexible Circuit Board Extender
Order 067-0974-00 ..... **$100**

CG 551AP Field Modification Kit to convert to CG 5001
Order 040-1041-02 ..... **$95**

PG 506



Calibration Generator

PG 506

Three Squarewave Output Modes

10 Hz to 1 MHz

Direct Readout of Oscilloscope Deflection Error

The PG 506 Calibration Generator provides three modes of squarewave output, selectable dc outputs, and a variable-amplitude output with front-panel digital indication of oscilloscope deflection error. Simultaneous plus and minus low-level, fast-rise (1.0 ns) squarewaves or high amplitude (60 V), extremely clean squarewaves are available at frequencies from 10 Hz through 1 MHz for checking oscilloscope transient response. A 5 mA calibration current loop is useful for current probe calibration. A 1 kHz squarewave can be generated in the amplitude calibration mode. Its amplitude may be varied around the calibrated level until the squarewave aligns with the oscilloscope vertical graticule divisions. Scope deflection error then can be read directly off the PG 506 digital display in percentage high or low, permitting rapid verification of oscilloscope performance.

CHARACTERISTICS

AMPLITUDE CALIBRATOR MODE

Period — Fixed at ≈1 ms or dc.

Amplitude — From 200 μV p-p to 100 V p-p in 1-2-5 sequence, accurate within ±0.25% into 1 MΩ. 100 μV p-p to 5 V p-p into 50 Ω.

Error Readout — Range: ±7.5%. Resolution: 0.1%.

PULSE MODES

Period — 1 μs to 10 ms (within 5%) in decade steps with the Variable control in Cal position. Variable extends period to at least 100 ms.

Symmetry — ≈50% duty cycle.

HIGH AMPLITUDE OUTPUT

Risetime — Unterminated: 100 ns or less. Terminated into 50 Ω: 10 ns or less.

Amplitude Range — Unterminated: 6 V or less to at least 60 V. Terminated into 50 Ω: 0.5 V or less to at least 5 V.

Leading Edge Aberrations — Within 2% or 50 mV p-p, whichever is greater, when terminated into 50 Ω.

Polarity — Positive going from a negative potential to ground.

Output Resistance Source — 600 Ω within 5%.

FAST-RISE OUTPUTS

Risetime (Terminated into 50 Ω) — 1.0 ns or less.

Amplitude Range (Terminated into 50 Ω) — 100 mV or less to at least 1.0 V.

Leading Edge Aberrations — Within 2% or 10 mV p-p, whichever is greater, during first 10 ns.

Flatness — Within 0.5% after first 10 ns.

Polarity — Simultaneous positive and negative going. Positive going is from a negative rest potential to ground. Negative going is from a positive rest potential to ground.

Output Resistance Source — 50 Ω within 3% at + and − output connectors.

Trigger Output (Terminated into 50 Ω) — Positive-going signal of at least 1 V.

Included Accessory — Instruction manual.

Order PG 506 Calibration Generator .. **$2,550**

TUNNEL DIODE PULSER

The Tunnel Diode Pulser provides a clean, fast-rise pulse for adjusting the transient response of high-frequency oscilloscopes and other instruments. The Tunnel Diode Pulser can be driven by the PG 506 Calibration Generator at repetition rates exceeding 50 Hz. Output amplitude of the pulse is approximately 250 mV into 50 Ω, while risetime is ≤125 ps; aberrations are <1% in a 1 GHz system.

Order 067-0681-01 ..... **$155**

PRECISION VOLTAGE DIVIDER

Designed for use with the PG 506 in the Standard Amplitude mode, this 0.4 divider allows your oscilloscope to display a constant four divisions when checking amplitude calibration from 20 μV/div through 1 V/div. It also allows the PG 506 to be more conveniently used with oscilloscopes that cannot display five divisions of amplitude.

CHARACTERISTICS

Input Z — 50 Ω with output load ≥100 kΩ.

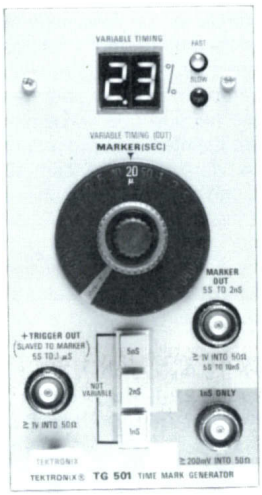
Maximum Input — ≤5 V RMS.

Output — 0.4 x PG 506 amplitude.

Voltage Accuracy — ±0.4%.

Order 015-0265-00 ..... **$140**

TG 501



Time Mark Generator

TG 501

Marker Outputs, 1 ns to 5 s

Direct Readout of Oscilloscope Timing Error

External Trigger Output

The TG 501 Time Mark Generator provides marker outputs from one nanosecond to five seconds. A unique feature on the TG 501 is a variable timing output with a front-panel two-digit LED display. The display indicates percentage of timing error between the normal time interval and a variable interval set to line up the marker pulse with graticule or division mark on the display. This feature not only provides direct readout in terms of percent error, but also helps eliminate errors associated with visually estimating error from a display.

CHARACTERISTICS

Markers — 1 ns through 5 s in a 1-2-5 sequence.

Marker Amplitude — ≥1 V peak into 50 Ω on 5 s through 10 ns markers. ≥750 mV p-p into 50 Ω on 5 ns and 2 ns markers. ≥200 mV p-p into 50 Ω on 1 ns markers.

Trigger Output Signal — Slaved to marker output from 5 s through 100 ns. Remains at 100 ns for all faster markers.

Internal Time Base	Standard	Option 01
Crystal Frequency	1 MHz	5 MHz
Stability (0°C to 50°C) after ½ hour	within 1 part in 10^5	within 5 parts in 10^7
Long-Term Drift	1 part or less in 10^5 per month	1 part or less in 10^7 per month
Setability	adjustable to within 1 part in 10^7	adjustable to within 5 parts in 10^9

External Reference Input — Available with internal changes. Acceptable frequencies, 1 MHz, 5 MHz, or 10 MHz. Input amplitude must be TTL compatible.

Timing Error Readout Range — To ±7.5%.

Timing Error Measurement Accuracy — Device under test error is indicated to within one least significant digit (to within one displayed count).

Included Accessory — Instruction manual.

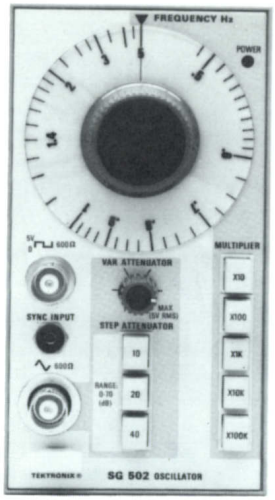
ORDERING INFORMATION

TG 501 Time Mark Generator **$2,050**

Option 01 — 5 MHz Time Base ..... **+$305**

For compatible accessories - refer to page 458.

SG 502



Oscillator

SG 502

5 Hz to 500 kHz Sinewaves and Squarewaves

Low Distortion Sinewave

5 V RMS Open Circuit—600 Ω Source

0 dB to 40 dB Output Variable Plus 0 dB to 70 dB in 10 dB Steps

The SG 502 Oscillator features a wide frequency range of 5 Hz to 500 kHz with low distortion (0.035% between 20 Hz and 50 kHz) and is desirable for general test purposes. Other SG 502 features include 70 dB amplitude control plus a simultaneous fixed amplitude squarewave.

CHARACTERISTICS

SINEWAVE

Frequency Range — 5 Hz to 500 kHz in 5 decade steps. Accurate within 5% of dial setting from 5 Hz to 50 kHz; within 10% of dial setting from 50 kHz to 500 kHz.

Amplitude Response (1 kHz Reference) — Flatness is 0.3 dB over entire range.

Attenuation — Selectable from 0 dB to 70 dB in 10, 20, and 40 dB steps with push buttons. Accurate within 0.2 dB for each step selected, additive. An uncalibrated control provides continuous variation from 0 dB to −40 dB.

Harmonic Distortion — <0.035% (−70 dB) from 20 Hz to 50 kHz. <0.15% from 50 kHz to 500 kHz (R_L ⩾600 Ω).

Maximum Output Voltage — 5 V RMS open circuit; 2.5 V RMS into 600 Ω.

Output Impedance — 600 Ω, grounded.

SQUAREWAVE

Frequency Range and Accuracy — Same as sinewave. The squarewave switches on the 0° phase of sine out.

Rise and Falltime — 50 ns or less.

Amplitude — +5 V, fixed, open circuit.

Output Impedance — 600 Ω, grounded.

SYNC INPUT

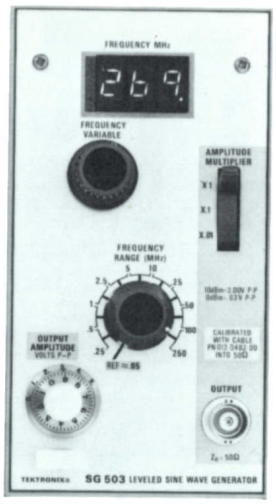
Oscillator can be synchronized to external signal. Sync range, the difference between sync frequency and set frequency, is a linear function of sync voltage.

Input Impedance — 10 kΩ.

Included Accessory — Instruction manual.

Order SG 502 Oscillator **$825**

SG 503



Signal Generator

SG 503

250 kHz to 250 MHz

Leveled, Variable Output

Digital Readout of Frequency

The SG 503 Signal Generator provides a leveled output that is variable in frequency from 250 kHz to 250 MHz. The selected frequency is indicated by a built-in autoranging frequency counter with a three-digit LED read-out on the front panel. Accurately calibrated output voltage is variable from 5 mV to 5.5 V peak-to-peak into 50 ohms.

CHARACTERISTICS

Frequency Range — 250 kHz to 250 MHz, plus 50 kHz reference frequency.

Frequency Accuracy — Within ±0.7 of one count of the least significant digit of indicated frequency.

Amplitude Range — 5 mV to 5.5 V p-p into 50 Ω termination in three decade ranges.

Amplitude Accuracy (50 kHz Reference) — Within 3% of indicated amplitude on (X1) range, 4% on (X.1) range, and 5% on (X.01) range.

Flatness (P-P) — From 250 kHz to 100 MHz, output amplitude will not vary more than 1% of the value at 50 kHz except that up to +1.5%, −1% variation may occur between 50 MHz and 100 MHz on amplitude multiplier X.1 and X.01 ranges only. From 100 MHz to 250 MHz, amplitude variation is within 3% of the value at 50 kHz.

Harmonic Content — Second harmonic at least 35 dB down. Third and all higher harmonics at least 40 dB down.

Other — Rear edge card connection available to address the leveling circuit.

INCLUDED ACCESSORIES

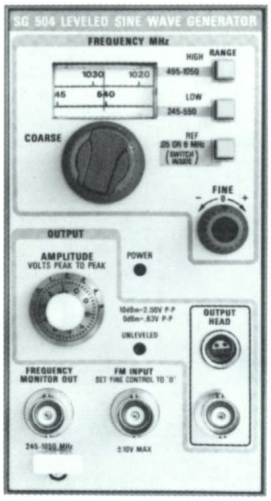
Three foot precision 50 Ω cable (012-0482-00); instruction manual.

Order SG 503 Signal Generator **$2,010**

Tektronix offers service training classes on the TM 500 Calibration Systems Package. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the center of this catalog.

For compatible accessories — refer to page 458.

SG 504



Signal Generator

SG 504

245 MHz to 1050 MHz

Leveled, Variable Output

Frequency Modulation Capability

The SG 504 Signal Generator provides a leveled output amplitude that is variable from 245 MHz to 1050 MHz in two bands. Frequency is indicated by a high-resolution tape dial that expands each band over 28 inches. The accurately calibrated output voltage is variable from 0.5 V to at least 4.0 V peak-to-peak into 50 Ω.

CHARACTERISTICS

Frequency Range — Low Band: 245 MHz to 550 MHz. High Band: 495 MHz to 1050 MHz, plus 50 kHz or 6 MHz reference frequency (internally selected).

Frequency Accuracy — ±2% of dial indication.

Amplitude Range — 0.5 V to at least 4.0 V p-p.

Amplitude Accuracy (At Reference) — Within 3% of indicated amplitude.

Flatness — ±4% of amplitude at reference frequency.

Harmonic Content — 2nd harmonic at least 25 dB down; 3rd and all higher at least 40 dB down.

FM Input — Frequency Range: Dc to 100 kHz. Deviation Sensitivity: ±9 V produces from ±0.05% to ±0.5% deviation of carrier, depending on output frequency.

Frequency Monitor Output — ⩾0.3 V p-p into a 50 Ω load from 245 MHz to 1050 MHz.

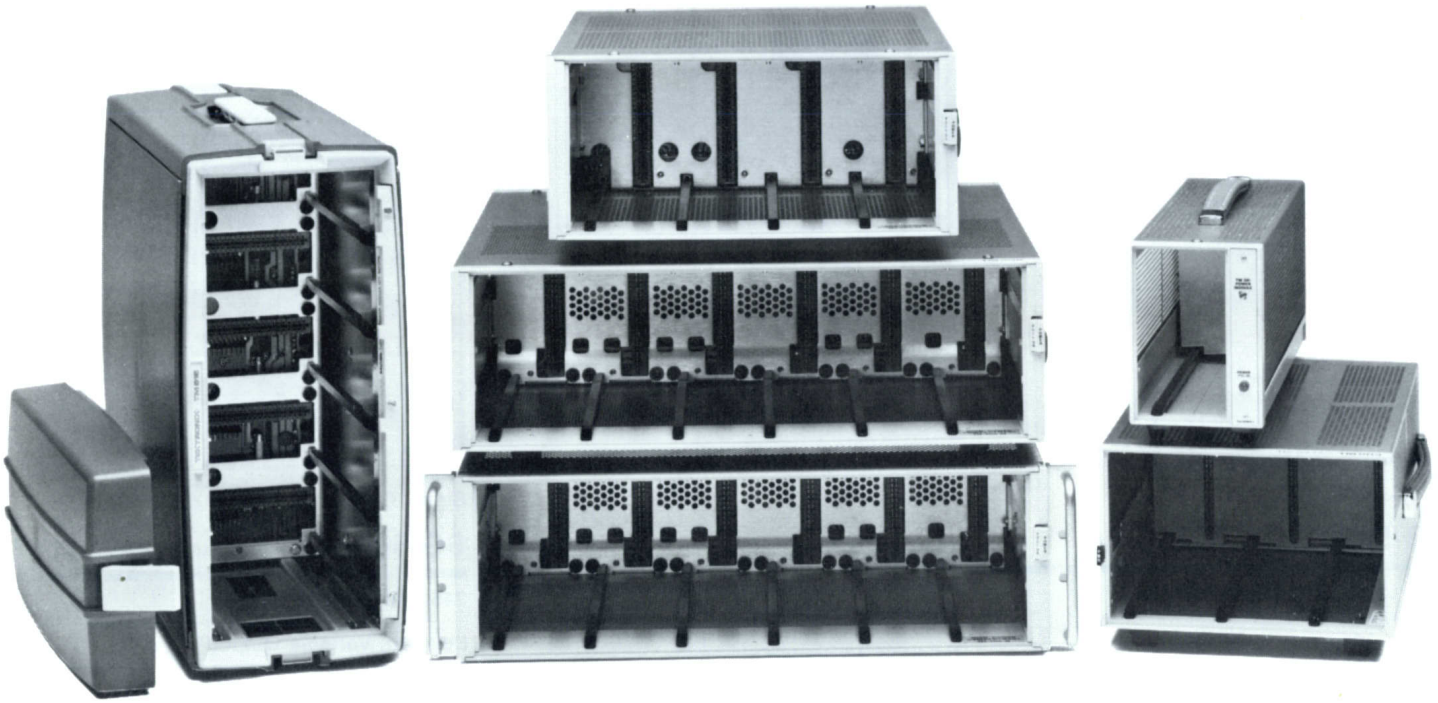
Rear Card Edge Connections — Address FM input, frequency monitor output, and amplitude control.

Included Accessory — Instruction manual.

ORDERING INFORMATION

SG 504 Signal Generator
(Includes Leveling Head) **$3,400**

Replacement Leveling Head
Order 015-0282-00 ..... **$450**



Shown above are the TM 515, TM 504, TM 506, RTM 506, TM 501 and TM 503 mainframes.

The TM 500/TM 5000 mainframes allow the multifunctionality of a package of instruments. Literally hundreds of combinations of instrumentation packages can be configured for specific tasks by using TM 500 plug-ins.

The TM 500 plug-in instruments operate in any of eight mainframes that accept instruments in combinations of up to six single-width plug-ins. One single-width plug-in instrument is accommodated by the TM 501. Up to six instruments can be accommodated in the TM 506 bench-top mainframe and the RTM 506 rackmount mainframe. Three and four-wide mainframes are also available and the five-wide Traveler Mainframe provides for applications that require instrument portability.

The TM 5000 mainframes extend the convenience of the TM 500 concept into the programmable instrument/IEEE Standard 488 area. The TM 5003 accepts up to three instruments at one time; the TM 5006 accepts up to six instruments at one time. These two TM 5000 mainframes were designed specifically for use with the Tektronix TM 5000 line of programmable, IEEE-488 compatible test and measurement instruments, but all of the TM 500 manual plug-in instruments will also operate in these same mainframes allowing manual and programmable instruments to be mounted together in adjacent slots. This capability permits unique compact combinations of test instruments to be assembled for specific test applications.

Any of the mainframes may be operated with less than a full complement of plug-in instruments installed. TM 5000 instruments cannot be operated in TM 500 mainframes.

Benchtop

The six benchtop mainframes are the TM 501, TM 503, TM 504, TM 506, TM 5003 and the TM 5006. The TM 503 and TM 5003 are the most compact of the multiple instrument units, each accommodating three single-wide plug-ins. The TM 504, TM 506, and the TM 5006 each include a high-power compartment at the right-hand end to supply higher current levels to instruments that provide higher performance or higher output levels. The TM 506, TM 5003 and TM 5006 incorporate a quiet fan for optimum cooling. All benchtop models have feet, tilt-bails, handles, and front-panel power switches. All operate from 110 V ac or 220 V ac.

Portability

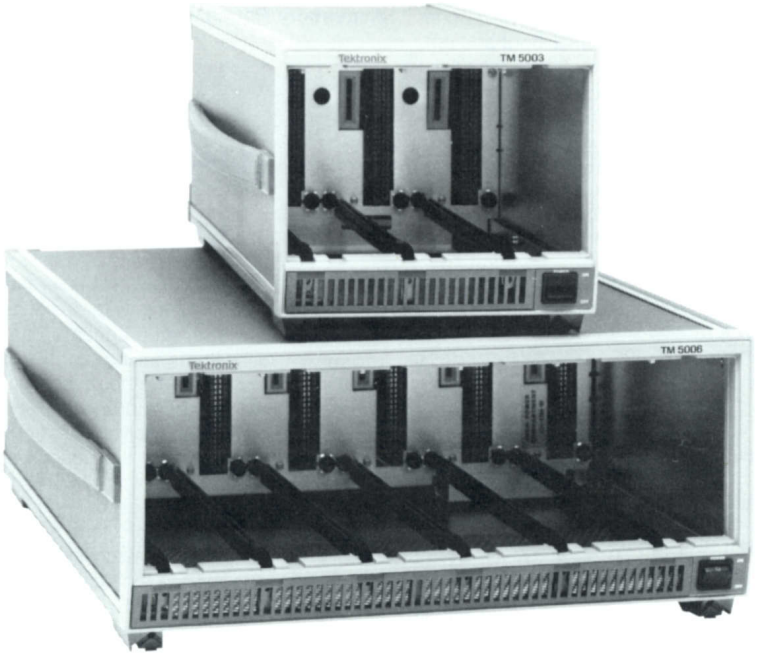
All benchtop models have carry handles for portable applications. TM 500 models further enhance portable applications with sturdy cord-wrap rear feet plus optional protective front covers. The TM 515 Traveler Mainframe, however, was designed for superior, multi-instrument portability. In its carrying configuration, it is a handsome piece of luggage with molded feet on the bottom and a comfortable, luggage-type handle. The TM 515 is extremely moisture and dust resistant and is designed to withstand the rigors of transport in car trunks and pickup trucks. Once at the destination, its rear cover is popped off to access the power cord and power switch and allow airflow for the built-in fan. Removing the front cover exposes up to five TM 500 plug-in instruments to reveal an operational electronics lab traveling as a suitcase.

Rackmount

The RTM 506 Rackmount Mainframe is electrically identical to the TM 506. The TM 5006 Option 10 is electrically identical to the standard TM 5006. Each instrument features a slide assembly and handles, plus a higher-power fan than the bench version to accommodate the higher ambient temperatures often found in enclosed racks and consoles. It is also possible to convert two TM 503's into a rackmount assembly with a kit. This kit has the advantage of requiring four inches less depth than the RTM 506 for space-critical applications, but lacks the fan and the high-power compartments. Other kits are available to rackmount a single TM 503, a TM 503 with a monitor, or a TM 5003 with a 4041 System Controller.

Rear Interface Capability

Most TM 500 plug-in modules contain a duplication of the front-panel input and output connections in the back. Some plug-in modules also have additional signal or control lines that are present only at the back of the instrument. These signals are available at the rear edge-card connector of each plug-in. Thus, the user can interconnect modules via the rear interface board to reduce front panel clutter and to perform functions not otherwise available. For example, the trigger output of a signal source can be interconnected to the rear input of a counter for instant frequency checks at the touch of a front-panel switch. Or, a digital multimeter and power supply may be interconnected to speed precise voltage setups without any need to move test leads. Any module can be internally connected through the mainframe and also can be externally interfaced out the back panel.



TM 5003 and TM 5006 mainframes shown above.

Mainframes can be interfaced in a variety of ways. A user can solder together the appropriate connector pins on a standard mainframe, or can order the mainframe with Option 02. Option 02 provides factory-installed square-pin conectors at the rear interface between the mainframe and the plug-in instruments, plus a multi-pin connector and one or more BNC connectors mounted on the rear panel of the mainframe. To allow as much flexibility as possible, these connectors are not prewired. A wire kit consisting of specially prepared jumper wires and coax cables is provided with the option. Then, interfacing between instruments within a mainframe and with external devices is simply a matter of connecting the appropriate terminals together.

The TM 515 Traveler Mainframe is available with the Option 05 interface which includes everything in the Option 02 except the rear panel multi-pin connector, the mating cable connector, and the BNC connector.

Economy

TM 500 and TM 5000 mainframes represent a most economical approach in test and measurement instrumentation. Relatively fixed packaging costs for frames, covers, primary power circuits, unregulated secondary power circuits, and other items are a significant portion of the cost of a typical instrument. Since these fixed costs associated with packaging are shared by many functional instruments in the TM 500 line, the cost-per-function may be lower than comparable, one or two-function monolithic instruments. Because of its modularity, expandability, and versatility, the modular concept represented by TM 500 may provide the lowest cost-per-test/measurement when you are considering multifunction usage.

The ability to upgrade to a higher-performance system without replacing the entire investment is made possible by the compatibility between the TM 500 and TM 5000 lines. Reduced cabling costs made possible by the rear-interface capability, the requirement for fewer GPIB cables for an equal number of instruments in the TM 5000 line; and the reduced space requirements for a measurement system all contribute to unprecedented economy for test and measurement requirements.

Power Requirements

All of the mainframes have manually selectable taps on the power transformer which permit operation on 100 V, 110 V, 120 V, 200 V, 220 V, or 240 V ±10%. Power line frequency range for the TM 501 and TM 503 is 48 Hz to 440 Hz. Power line frequency range for all of the other mainframes is 48 Hz to 66 Hz, except that the TM 515 may be purchased with Option 06 which extends its upper power line frequency range to 440 Hz. Maximum power consumption of each is shown in the following table.

ENVIRONMENTAL CHARACTERISTICS

Temperature Range — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude Range — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea Level to 15 000 m (50,000 ft).

ORDERING INFORMATION

GPIB IEEE-488

The TM 5003 and TM 5006 comply with IEEE Standard 488-1978.

TM 5003 Power Module Mainframe **$790**

Option 02 — Rear Interface ..... +$100

TM 5006 Power Module Mainframe ... **$1,050**

Option 02 — Rear Interface ..... +$180

Option 10 — Rackmount ..... +$100

Option 12 — Option 02 & Option 10 Combined ..... +$280

ORDERING INFORMATION

TM 501 Power Module Mainframe **$340**

Option 02 — Rear Interface ..... +$60

TM 503 Power Module Mainframe **$340**

Option 02 — Rear Interface ..... +$85

TM 504 Power Module Mainframe **$375**

Option 02 — Rear Interface ..... +$115

TM 506 Power Module Mainframe **$525**

Option 02 — Rear Interface ..... +$170

RTM 506 Rackmount Power Module Mainframe **$680**

Option 02 — Rear Interface ..... +$180

TM 515 Power Module Mainframe **$650**

Option 05 — Rear Interface ..... +$85

Option 06 — 48 Hz to 440 Hz Fan ..... +$165

CONVERSION KITS

Cabinet-to-rackmount conversion kit, equipped with slide out assembly, required to convert a TM 5006 to rackmount capability.
Order 040-0982-01 ..... **$160**

Rackmount-to-cabinet conversion kit, equipped to convert a TM 5006 with rackmount capability to cabinet style.
Order 040-0983-00 ..... **$60**

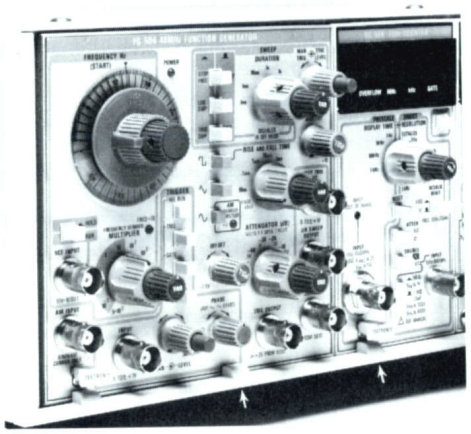
Cabinet-to-rackmount conversion kit, equipped with slide-out assembly to rackmount a 4041 Instrument Controller to the left of a TM 5003.
Order 040-0984-00 ..... **$190**

MAINFRAMES DIMENSIONS AND WEIGHTS (WITHOUT PLUG-INS)

	TM 5003		TM 5006		TM 501		TM 503		TM 504		TM 506		RTM 506		TM 515	
Dimensions	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**
Width	230	9.0	445	17.5	99	3.9	221	8.7	305	12.0	442	17.4	483	19.0	381	15.0
Height	194	7.6	194	7.6	152	6.0	152	6.0	152	6.0	152	6.0	133	5.3	173	6.8
Depth	488	19.2	488	19.2	389	15.3	432	17.0	508	20.0	508	20.0	480	18.9	508	20.0
Weight ≈	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net	8.6	19.0	14.5	32.0	2.4	5.4	4.3	9.5	8.4	18.5	13.2	29.0	14.4	32.0	10.2	22.5
Shipping	12.0	26.5	20.9	46.0	5.9	13.0	7.7	17.0	11.8	26.0	18.6	41.0	21.0	46.0	13.6	30.0
Max Power Consumption*1	300 VA		650 VA		85 VA		250 VA		460 VA		670 VA		670 VA		500 VA	

**1 Actual power consumption depends on plug-in selection and operating modes.*

Mainframe Retainer Bar



The mainframe retainer bar modification kit comes complete with the retainer bar, all necessary parts and instructions.

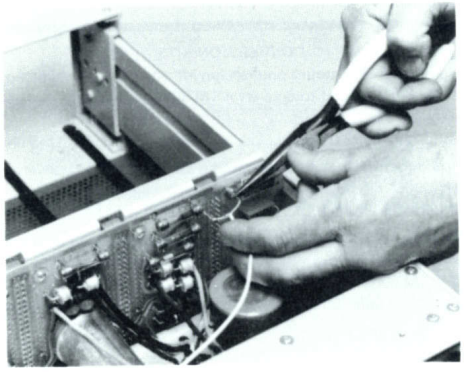
You may modify the TM 504 or RTM 506/TM 506 Mainframe; each has a separate kit. Initial installation requires replacement of an existing bottom member of the mainframe with a new part supplied in the kit. Then, the retainer bar can be simply added or removed with four screws accessible from the bottom of the mainframe.

ORDERING INFORMATION

TM 504 Mainframe Retainer Bar Kit
Order 020-0548-00 ..... **$45**

TM 506/RTM 506 Mainframe Retainer Bar Kit. Order 020-0549-00 ..... **$50**

TM 5000 Series Plug-in Retainer Kits in Process



Mainframe Rear Interface

TM 500 and TM 5000 Mainframes offer the unique ability to have separate modular instruments interconnected through the rear interface board of each mainframe. For example, the rear trigger output of a signal source can be interconnected to the rear input of a counter for instant frequency checks at the touch of a front-panel switch. Or, a digital multimeter and power supply may be interconnected to speed precise voltage set-ups without any need to move test leads. Any module can be internally connected through the mainframe and can also be externally interfaced out the back panel.

Most TM 500 and TM 5000 Plug-in modules contain a duplication of the front panel input and output connections in the back. These interface lines are built into the rear-edge circuit card connector of each plug-in. Some modules also have additional signal or control lines which are present only at the back of the instrument. In either case, different modules may be interconnected by the user to reduce front panel clutter or to perform functions not otherwise available.

Mainframes can be interfaced a variety of ways. A user can solder together the appropriate connector pins on a standard mainframe, or can order the mainframe with the Option 02. The Option 02 version of the mainframe comes equipped with square pin connectors on the rear interface circuit board and a special wire kit consisting of standard wires and coaxial cables with mating square pin receptacles. Option 02 also provides a rear-panel male connector, mating cable connectors, and one BNC connector per plug-in compartment.

The square pin connectors eliminate the need to hand-solder connections to the interface circuit board, extending the life of the mainframes. The remaining Option 02 components offer a variety of interfacing alternatives limited only by the user's ingenuity and imagination.

The TM 515 Mainframe is available with an Option 05 interface that includes everything in the Option 02 except for the rear panel male connector, mating cable connector and the BNC connectors.

Tektronix has published a Rear Interface Data Book that contains information on the interfacing capability of each instrument "family." This book is available through Tektronix by filling out a card included in each mainframe package.

Tektronix also makes a low-cost "do-it-yourself" Rear Interface Modification Kit. It enables those who don't need the full flexibility of factory installed interface pins at every connector to install a limited rear interface on any TM 500 and TM 5000 Mainframe except the TM 501. The kit includes fourteen square pins, and three coaxial cables, all with female pin receptacles. Installation instructions also included. For "do-it-yourself" modification kit:

Order 040-0846-01 ..... **$49**

Accessory Pouch

While the TM 501, TM 503, TM 504, and TM 506 TM 5003/5006 Mainframes were designed primarily for bench use, they are frequently carried away for service elsewhere. Taking along the probes, cables, terminators, and other accessories usually required can then be a problem. The soft vinyl accessory pouch neatly solves this problem; sturdy snap-around straps let the pouch be secured to the carrying handle of any TM 500/5000 Mainframe or Tektronix Oscilloscope, or the straps may be snapped together to form a carrying handle for the pouch to be used independently. A convenient side zipper lets accessory items be removed or stored without removing the pouch from the mainframe handle. Dimensions ≈9¼ in long x 5¾ in wide x 2 in high.

Order 016-0351-00 ..... **$25**

TM 500 Carrying Case

These luggage-type carrying cases for TM 500 equipment are molded of high strength glass-epoxy. The TM 503 model weighs 12 pounds empty and measures 23½ inches long by 8½ inches thick by 153½ inches high, including rubber feet, lockable latches, and handle. Inside, the resilient polyurethane foam is molded to accept a TM 503 (with or without the protective front cover) plus either a spare TM 500 family module or a 200 Series Miniscope. A third compartment in the foam accepts miscellaneous cables, accessories, or small tools.

The TM 504 case has a molded foam insert that will accept the TM 504 (with or without the protective front cover) but has no provisions for spare modules or tools. It is 610 mm long x 216 mm thick x 445 mm high, (24 in. long by 8.5 in. thick by 17.5 in high) and weighs ≈14 pounds empty.

ORDERING INFORMATION

Carrying Case for TM 503
Order 016-0565-00 ..... **$395**

Carrying Case for TM 504
Order 016-0608-00 ..... **$425**

Carrying Case for TM 515
Order 016-0643-00 ..... **$400**

Tek Lab Cart Model 3

This Lab Cart is especially designed for a rollabout configuration combining TM 500/5000 Instrumentation with the Tektronix oscilloscope of your choice. It features pistol-grip tilt control and a large accessory drawer in the base. The top tray accepts any Tektronix 7000 Series, 5000 Series, or portable oscilloscope. The Model 3 comes standard with one lower shelf that will support either a TM 503 or TM 504 with plug-ins. Additional shelves are available as optional accessories. Maximum capacity of the lower shelf area is two TM 503's or TM 504's, stacked, or up to a Tektronix 7000 Series oscilloscope in size—with TM 500 packages placed on the tray at your option. The power distribution module on the rear underside of the top tray provides four power outlets and a 15 foot line cord.

International modification (Option 01) deletes power distribution module.

ORDERING INFORMATION

TEK Lab Cart Model 3 (Blue) **$560**

TEK Lab Cart Model 3D (Brown) **560**

Option 01 — Without Power Distribution Module ..... **NC**

Additional Lower Shelf (TM 500 Only)

Order 436-0132-01 (Blue) **$37**

Order 436-0132-02 (Brown) **$55**

Safety Belt to secure oscilloscopes or TM 500/5000 to top tray or lower shelves (not needed for 5000 or 7000 Series on top tray).

Order 346-0136-01 ..... **$24**

Protective Front Cover

A snap-on front cover, molded of high impact plastic, is available for the TM 503 (shown above), TM 504, and TM 506 Mainframes. The cover adds 45 mm (1.75 in) to the length of the TM 503, TM 504, and TM 506 Mainframes, and clears the longest knob projections on any of the instruments.

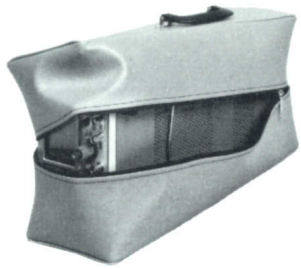
ORDERING INFORMATION

TM 503 Front Panel Cover
Order 200-1566-00 ..... **$18**

TM 504 Front Panel Cover
Order 200-1727-00 ..... **$17**

TM 506 Front Panel Cover
Order 200-1728-00 ..... **$20**

Rain Covers



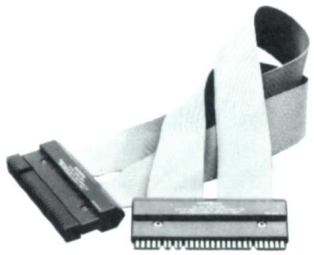
These soft, weather-proof, vinyl-coated Rain Covers come in sizes for TM 503 and TM 504 instrumentation packages and include adequate space for protective front covers, as well. They feature heavy-duty zippers that open from either end, and include their own carrying handles, offset to compensate for the off-center balancing point of TM 500 instrumentation packages. The color is Tek blue.

ORDERING INFORMATION

TM 504 Rain Cover
Order 016-0621-00 ..... **$45**

TM 503 Rain Cover
Order 016-0620-00 ..... **$35**

Flexible Plug-in Extender Cable



Designed to couple a TM 500 or TM 5000 Plug-in with the mainframe rear interface board connection extender, cables provide a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out.

ORDERING INFORMATION

GPIB Extender Cable
Order 067-0996-00 ..... **$110**

Extender Cable
Order 067-0645-02 ..... **$130**

1105 Battery Power Supply

TM 500 Instruments in their mainframes may be operated with the 1105 Battery Power Supply when suitable ac line power is not available. The 1105 is rugged and portable, operating on internal batteries or an external dc source. Operating time is dependent on the number and type of plug-ins being powered, and their operating mode. The following table shows estimated operating time for a full mainframe in a typical situation.

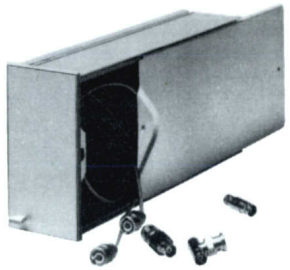
TM 501	5.0 hours
TM 503	1.6 hours
TM 504	1.3 hours
TM 506	0.9 hours
TM 515	1 hour

ORDERING INFORMATION

1105 Battery Pack **$1,430**

Option 01 — 230 V Operation ..... **NC**

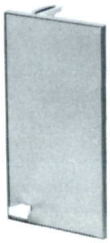
Plug-in Storage Compartment



An electronic engineer or technician away from their bench seldom has enough storage space for probes, cables, "tees", accessories, and small tools. The plug-in storage compartment is a useful adjunct to many rollabout and Travel Lab configurations. If all five compartments in your TM 515 Traveler Mainframe are not used for a particular field application, add a plug-in storage compartment for extra convenience. Even a rackmount TM 500 installation might profit by readily-available terminators or attenuators in a presently unused compartment. Compatible with all TM 500 Mainframes and 5000 Series Oscilloscope Mainframes; inside dimensions 250 mm L x 51 mm W x 106 mm H, (9⅞ in L x 2 in W x 4¼ in H).

Plug-in Storage Compartment
Order 016-0362-01 ..... **$125**

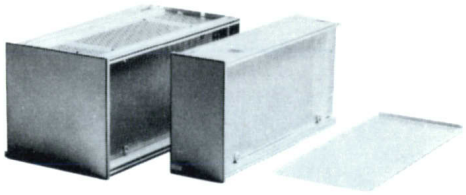
TM 500/5000 Blank Panel



When operating TM 500/5000 Instruments with less than the full complement of plug-ins, the blank plug-in panel can be used to cover unused compartments.

Blank Plug-in Panel
Order 016-0195-03 ..... **$25**

TM 500 Custom Plug-in Kits



Single and double compartment sizes
A complete test and measurement set-up for many typical jobs requires at least one nonstandard item. Such items commonly include relay circuits or manual switches for routing signals; test oscillators at pre-set frequencies for alignment purposes and markers; digital logic circuits for sequencing, timing, and control; special processors or converters such as log amps, multipliers, and analog-to-digital converters; and a variety of other system elements which are usually not available or economical as complete commercial instruments. The construction and packaging of these special items is always a problem, and the sheet metal work and provision for necessary power supplies often far exceeds the cost of the functional elements. This is why the TM 500 line includes custom plug-in kits. The kits provide perforated main circuit boards that allow rapid construction and wiring of circuits using both discrete components and integrated circuits. Also included are top and bottom rails, side cover, front sub-panel, and a blank dress panel, and the latch mechanism. An instruction sheet details the voltages and currents available in the power module. Standard voltage regulator ICs can be used to provide exact voltages for most individual power supply requirements. The finished special-purpose circuitry or instrument is physically compatible with other TM 500 Instrumentation.

Single Compartment with Power Supply
A blank plug-in kit complete with power supply parts and circuit board layout is now available. A single-wide compartment, this plug-in kit saves set up and build time as the power supply circuitry is designed and kitted for you.

Specifically, the supplies parts are:

(1) A ground-referenced positive supply, capable of +7 V to +20 V at up to 400 mA. (Adjustment is centered at 15 V; change of resistor values required for total 7 V to 20 V range).

(2) A ground-referenced negative supply, identical to supply No. 1 except for polarity.

(3) A ground-referenced supply nominally 5 V, not adjustable, with current capability up to 1 ampere.

A series of TM 500 Construction Notes provide direction for building custom circuits using the TM 500 Blank Plug-in Kits and standard components. Among the construction notes available are: Suggested Power Supply Circuits and Thermal True RMS Converter:

ORDERING INFORMATION

Custom Plug-in Kit — With Power Supply (Single Compartment)
Order 040-0803-02 ..... **$115**

Custom Plug-in Kit — Single Compartment
Order 040-0652-05 ..... **$95**

Custom Plug-in Kit — Double Compartment
Order 040-0754-07 ..... **$125**

Custom Plug-in Kit — Single Compartment Without ECB. **Order** 040-0821-03 ..... **$60**

GPIB ACESSORIES FOR TM 5000 SERIES

GPIB CABLES

GPIB Cable — .5 m. Order 012-1015-00 ..... **$65**

GPIB Cable — 2 m. Order 012-0630-01 ..... **$75**

GPIB Cable — 4 m. Order 012-0630-02 ..... **$115**

GPIB Cable — 2 m, double shielded. Order 012-0630-03 ..... **$90**

GPIB Cable — 4 m, double shielded. Order 012-0630-04 ..... **$150**

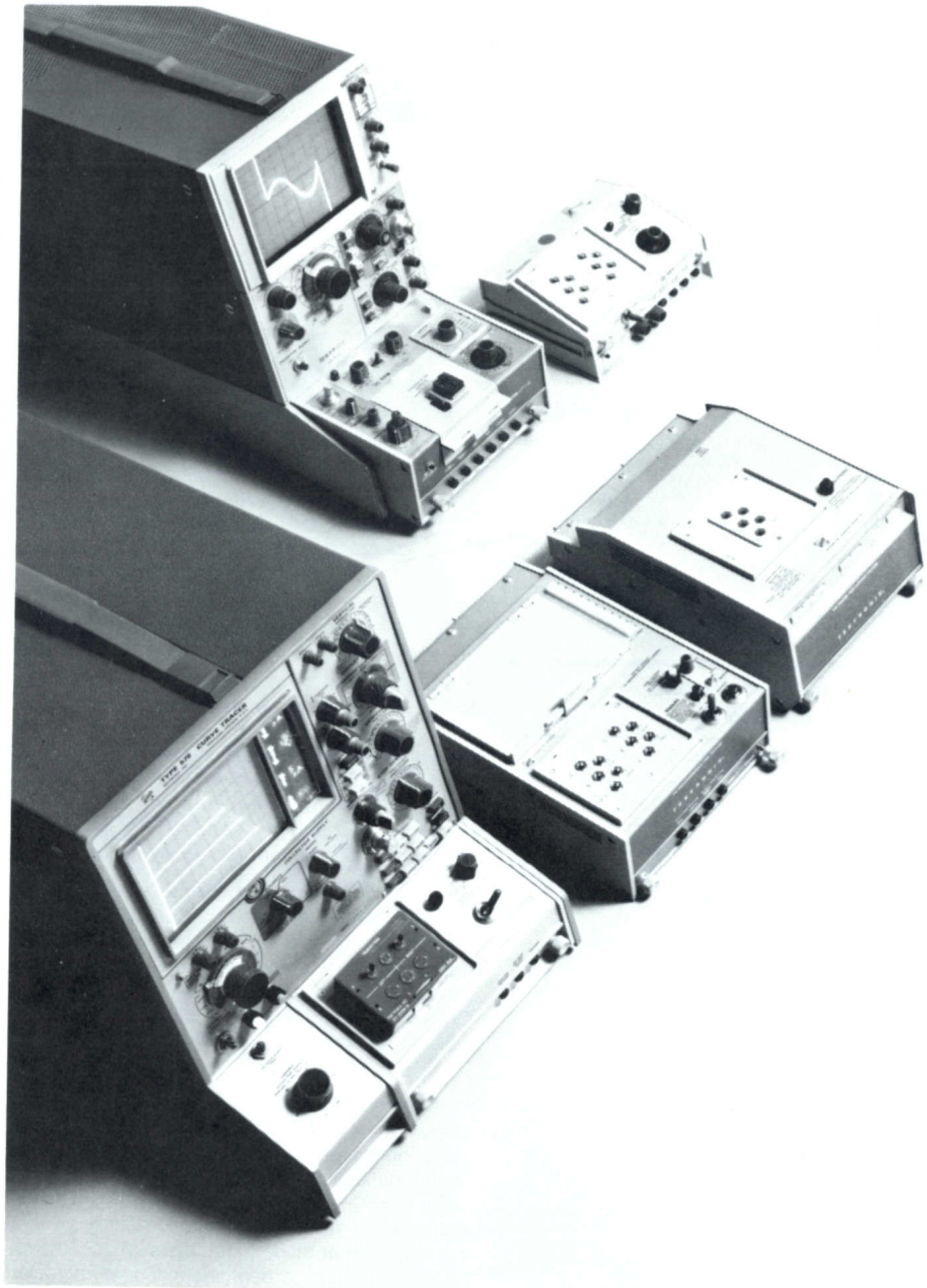
GPIB EXTENDER

4932 GPIB Extender — Provides a cost-effective way to interconnect remotely located GPIB instruments, allowing communication at distances up to 500 meters (1650 feet). See page 139 for additional information. **$1,195**

CURVE TRACERS

CONTENTS

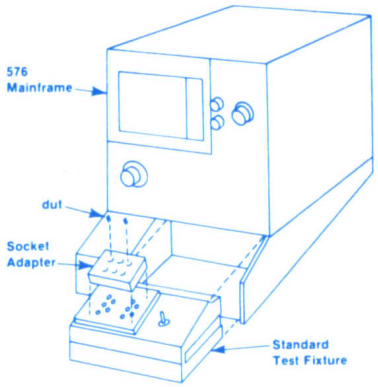
576 Curve Tracer System 408
172 Programmable Test Fixture 410
176 Pulsed High-Current Fixture 411
577 Curve Tracer System 412
178 Linear IC Test Fixture 414
5CT1N & 7CT1N Curve Tracer Plug-Ins 415
Socket Adaptors 416



Curve Tracers can deliver comprehensive information about a multitude of semiconductor devices and integrated circuits, from two- and three-terminal devices through the full range of linear integrated circuits, from transistors and diodes to optoisolators, thyristors, and operational amplifiers.

These versatile measurement tools give you more than pinpointed parameters. A curve tracer can show you what happens between specified points in a quickly graphed curve, thus providing the valuable performance data necessary for accurate design, analysis, and evaluation.

If you are well acquainted with Curve Tracers, you will find the Curve Tracer System descriptions in this section helpful in choosing the system that best meets your requirements. If you would like to receive a brochure, application notes, and other materials to learn more about Curve Tracers and their measurement capabilities, please use the reply card; or, for faster action, contact a Tektronix Sales Engineer at the Sales Office nearest you.



576

Tests Two- and Three-Terminal Discrete Semiconductors

Power Capability Up to 220 W

Convenient Scale Factor Readout

Other Test Fixtures for Testing Power Devices and Semiautomated Testing

The Tektronix 576 Curve Tracer System continues to hold the title "standard of the industry". The 576 accepts three different test fixtures: the Standard Test Fixture, 172 Programmable Test Fixture (see Alphanumeric Index), and the 176 Pulsed High-Current Fixture (see Alphanumeric Index). The 576 is an excellent general purpose curve tracer system that performs well in applications where high-current testing is required.

With the Standard Test Fixture, the collector supply of the 576 delivers up to 220 watts peak to the device under test. The step generator can deliver up to 2 amps in both its current and voltage modes of operation. With the 176 High-Current Fixture, the 576 is capable of pulsed collector operation up to 200 amps peak.

One of the features that sets the 576 apart from the Tektronix 577 Curve Tracer System is the display area adjacent to the 576's CRT. These alphanumeric indicators provide vertical and horizontal deflection factors, step amplitude, and Beta/div or g_m/div. The Beta or g_m readout saves the operator from the arithmetic usually necessary to arrive at these parameters. These indicators also provide a permanent record of major knob settings in 576 CRT photographs.

Another unique feature of the 576 is the Calibrated Display Offset. Combining a calibrated position control and a display magnifier, the Display Offset increases resolution and allows the operator to make more precise measurements.

Other features of the 576 Curve Tracer include: adjustable current limiting in the step generator, either 300 μs or 80 μs pulse width in pulsed base operation, pushbuttons to check display zero and calibration, and an illuminated graticule.

CHARACTERISTICS

COLLECTOR SUPPLY

Modes

Norm: Positive or negative full-wave rectified ac (line frequency); dc positive or negative.

Leakage: Emitter current rather than collector current measurements with an increase in the basic vertical deflection factor to 1 nA/div.

Voltages[*1]

Range	15 V	75 V	350 V	1500 V
Max Continuous Peak Current	10 A	2 A	0.5 A	0.1 A
Peak Pulse Mode Current	≥20 A	≥4 A	≥1 A	≥0.2 A

*[*1] Peak open circuit voltages within +35% and −5% of indicated range.*

Series Resistance — From 0.3 Ω to 6.5 MΩ in 12 steps, all within 5% or 0.1 Ω. Peak Power Limit Setting: 0.1 W, 0.5 W, 2.2 W, 10 W, 50 W, 220 W.

Safety Interlock — Protects operator from 75 V, 350 V, and 1500 V collector voltages.

STEP GENERATOR

Current Mode — Step/Offset Amplitude Range: 5 nA/mV/step (with X0.1 Mult) to 2 V/step, 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): X20 Amplitude setting, except X10 (2 A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Maximum Voltage (Steps and Aiding Offset): At least 10 V. Maximum Opposing Offset Current: X10 Amplitude switch setting or 10 mA, whichever is less. Maximum opposing voltage is limited at 1 V to 3 V.

Voltage Mode — Step/Offset Amplitude Range: 5 mV/step (with X0.1 Mult) to 2 V/step, 1-2-5 sequence. Maximum Voltage (Steps and Aiding Offset): X20 Amplitude switch setting, 40 V max. Maximum Current (Steps and Aiding Offset): At least 2 A at 10 V, derating linearly to 10 mA at 40 V. Short Circuit Current Limiting: 20 mA, 100 mA, 500 mA +100%, −0%; 2 A +50%, −0%. Maximum Opposing Offset Voltage: X10 Amplitude switch setting. Maximum Opposing Current: Limited at 5 mA to 20 mA.

Accuracy

Incremental: Within 5%, between steps, within 10% with X1.0 Mult.

Absolute: Within 2% of total output including offset, or 1% of Amplitude setting, whichever is greater.

Offset Multiplier: 0 to X10 the Amplitude setting, continuously variable. Polarity Aid(s) or Oppose(s) the step polarity.

Step Rates — X0.5, X1 (Norm), and X2 the collector supply rate. The collector supply rate is twice line frequency.

Pulsed Steps — ≈80 μs or 300 μs width, at Norm or X0.5 rates.

Offset Step/Offset Polarity — The Step Gen polarity is the same as the Collector Supply polarity, and positive in the ac position. Step polarity may be inverted by actuating the Invert pushbutton.

Step Family — Repetitive or Single Family (manually actuated).

Number of Steps — Digitally selectable between one and ten.

DEFLECTION CONTROLS

Display Accuracies[*1]

		OFFSET and MAGNIFIED with CENTERLINE VALUE from:		
NORM and Dc MODES	**Normal**	**100-40 div**	**35-15 div**	**10-0 div**
Vert Collector Current	3%	2%	3%	4%
Horiz Collector Volts	3%	2%	3%	4%
Horiz Base Volts	3%	2%	3%	4%
LEAKAGE MODE Vert Emitter Current/div:		NOT APPLICABLE		
10 nA-2 mA/div	3% ± 1 nA			
1 nA-200 μA/div (Magnified)		2% ± 1 nA	3% ± 1 nA	4% ± 1 nA
5, 2, 1 nA/div	5% ± 1 nA	NOT APPLICABLE		
Horiz Collector or Base Volts with Emitter Current/div of:				
≥1 μA	3%	2%	3%	4%
100, 10, or 1 nA	3% plus 25 mV/ vert div	NOT APPLICABLE		
200, 20, or 2 nA	3% plus 50 mV/ vert div			
500, 50, or 5 nA	3% plus 125 mV/ vert div			
Vert Step Gen Position	4%	3%	4%	5%
Horiz Step Gen Position	4%	3%	4%	5%

*[*1] With standard test fixture, shown as a percentage of highest on-screen value .*

Vertical Deflection Factor — Collector Current: 1 μA/div to 2 A/div, 20 steps in 1-2-5 sequence (0.1 μA/div with X10 magnification). Emitter Current: 1 nA/div to 2 mA/div, 20 steps in 1-2-5 sequence. Step Generator: 1 step/div.

Horizontal Deflection Factor

Collector Volts: 50 mV/div to 200 V/div 12 steps (5 mV/div with X10 magnification).

Base Volts: 50 mV/div to 2 V/div, 6 steps (5 mV/div with X10 magnification).

Step Generator: 1 step/div.

Displayed Noise[*1]

Range	15 V	75 V	350 V	1500 V
Vertical — Collector	1 μA	1 μA	2 μA	5 μA
Vertical — Emitter	1 nA	1 nA	1 nA	5 nA
Horizontal — Base	5 mV	5 mV	5 mV	5 mV
Horizontal — Collector	5 mV	5 mV	20 mV	200 mV

*[*1] 1% or less, or the values shown.*

Calibrator (Cal) — Dc voltage (accurate within 1.5%) provided to check and adjust vertical and horizontal gain.

Position Controls — Fixed 5 div increments within 0.1 div. Continuous fine control over 5 div or less.

Display Offset — 21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with X10 Magnifier.

CRT AND READOUT

CRT — 165 mm (6.5 in) rectangular with parallax-free, illuminated graticule in centimeters. The calibrated area is 10 cm vertical by 10 cm horizontal (12 cm usable horizontal). GH (P31) Phosphor standard normally supplied.

Readout — The readouts, adjacent to CRT, are digital indicators of the following parameters: Per Vert Div from 1 nA/div to 2 A/div; Per Horiz Div from 5 mV/div to 200 V/div; Per Step from 5 nA/step to 2 A/step, 5 mA/step to 2 V/step; β (Beta) or g_m, Per Div from 1 μ to 500 k calculated from Current/Div, X10 Mag, Step Amplitude, and X0.1 Mult.

STANDARD TEST FIXTURE

Description — A plug-in fixture wth two sets of five pin test terminals, the Emitter Grounded or Base Grounded switch, Left-Off-Right switch, Step Gen Output Ext Base or Emitter input and the Operator Protection Box. The test terminals accept either the six pin universal adaptors, three pin adaptors, or the high-power transistor adaptors with Kelvin contacts.

POWER REQUIREMENTS

Power Source — Operates only with an unbalanced-to-ground power source. For safe operation, the power line neutral (white or "identified" conductor) must be connected to the instrument neutral (unfused), and the power plug safety ground (green conductor) must return to ground through a different path than the power line neutral.

Voltage Ranges — The quick-change line-voltage range selector accommodates 90 V ac to 136 V ac or 180 V ac to 272 V ac (six positions) at a line frequency of 48 Hz to 66 Hz.

Maximum Power Consumption (With or Without Adaptors) — 305 W. Standby Power: ≈60 W.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	292	11.5
Height	381	15.0
Depth	584	23.0
Weights	**kg**	**lb**
Net	32.0	70.5
Shipping ≈	48.5	107.0

INCLUDED ACCESSORIES

Transistor adaptor (013-0098-02); FET adaptor (013-0099-02); TO3 adaptor (013-0100-01); TO66 adaptor (013-0101-00); axial lead diode adaptor (013-0111-00); stud diode adaptor (013-0110-00); Kelvin sensors for large and small plastic transistors (013-0138-01); protective cover (337-1194-00); instruction manual.

ORDERING INFORMATION

576 Curve Tracer
with Standard Test Fixture **$10,755**

The 576 Option 01 deletes the parameter readout module but maintains provisions for insertion of the module (020-0031-00) at any time.

Option 01 ..... **−$700**

Auto Scale-Factor Readout Module —
Order 020-0031-00 ..... **$1,500**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

OPTIONAL ACCESSORIES

Test Setup Chart — Package of 250.
Order 070-0970-01 ..... **$10**

172 — Test Fixture. (See page 410.) **$4,515**

176 — Test Fixture. (See page 411.) **$5,105**

Socket Adaptors — (See page 416.)

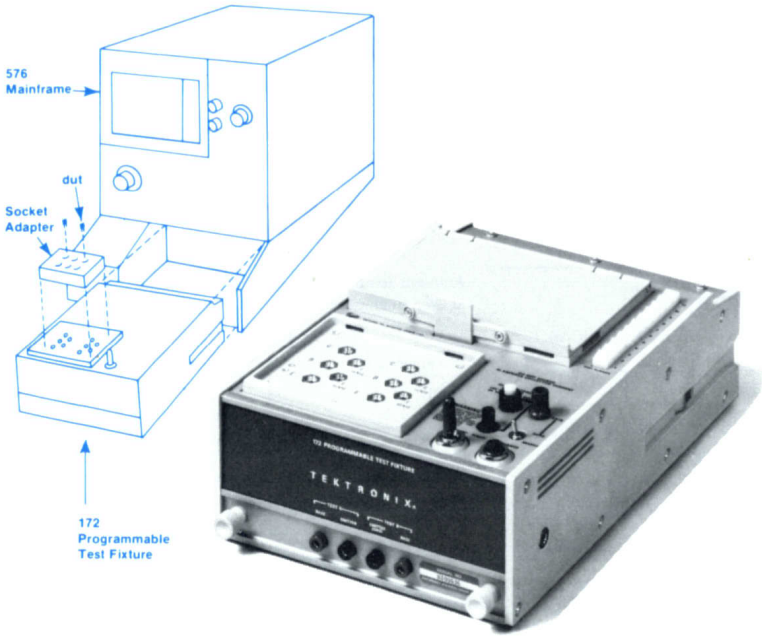
Camera — C-59A and adaptor.
(See page 424.) **$1,275**

172

Semiautomated Test Fixture

Tests Up to 11 Parameters

Reduces Total Test Time



The 172 Programmable Test Fixture, when used with the Tektronix 576 Curve Tracer, permits the operator to program a sequence of tests of J FETs, transistors, and diodes.

The 172 can greatly reduce total test time in applications when more than one measurement is made on a batch of many devices. Without the 172, all devices in the batch must be repeatedly inserted in the test fixture, once for every measurement. However, the 172 Programmable Test Fixture performs as many as eleven different tests on each device.

The 172 sequences through the various tests either automatically or manually. A variable rate control is provided to set the test sequence at a rate which is best for the operator. New operators require more time per test, but with experience they will want to test at a faster rate. A front-panel switch or an optional foot switch advances the test in the manual mode.

CHARACTERISTICS

VERTICAL AND HORIZONTAL AMPLIFIERS

Display Accuracies — The same as the 576 Curve Tracer with its included Standard Test Fixture.

Vertical Deflection Factor — Tests 1 and 2 (Collector or Emitter Current): 1 1 μA to 2 A/div in 20 steps. Tests 3, 4, and 8, 9, 10, 11 (Collector or Breakdown Current): 1 μA to 0.5 A/div in 18 steps. Tests 5, 6, 7 (Leakage Current): 1 nA to 0.5 A/div in 27 steps. All steps are in a 1-2-5 sequence.

Horizontal Deflection Factor — Test 1: 0.05 V/div to 200 V/div in 12 steps. Test 2 (Base Voltage): 100 mV/div to 2 V/div in 5 steps. Input Z for Test 2: At least 100 MHz at 100 mV/div and 200 mV/div. 1 MΩ (within 2%) at 0.5 V/div, 1 V/div, and 2 V/div. Tests 3 and 4 (Collector Voltage): 100 mV/div to 2 V/div in 5 steps. Tests 5 through 11 (Breakdown or Leakage Voltage): 100 mV/div to 50 V/div in 9 steps. All steps are in a1-2-5 sequence.

Collector Sweep Voltage — At least 2 V open circuit, or 1.5 A short circuit, at 100 mV/div and 200 mV/div. At least 5 V open circuit, or 2 A short circuit, at 500 mV/div. At least 20 V open circuit, or 150 mA short circuit, at 1 V/div and 2 V/div.

Current Supply Accuracy — 0.1 μA to 11 mA, accurate within 2% ±30 nA with up to 500 V compliance. 10 mA to 110 mA, accurate within 2% ±30 nA with up to 50 V compliance. Increments of current are: 0.1 μA (from 0.1 μA to 11 μA), 1 μA (from 10 μA to 110 μA), 10 μA (from 100 μA to 1.1 mA), 100 μA (from 1 mA to 11 mA) and 1 mA (from 10 mA to 110 mA).

Voltage Supply Accuracy — 1 V to 500 V, accurate within 3% ±300 mV with at least 0.5 mA compliance.

Test Display Time Range (Automatic) — 300 ms or less to at least 2 s continuously variable. Manual operation from a front-panel switch or optional foot switch.

TESTS THAT CAN BE PERFORMED ON:				PROGRAMMABLE CAPABILITIES
Test	Xstr	J FETs	Diodes	
1*1	H_{FE} $V_{CE(sat)}$	V_P	V_F	Peak Current up to 10 A Peak Volts up to 350 V.
2	V_{BE}			Horiz range is 100 mV/div to 2 V/div (other conditions same as Test 1).
3	H_{FE}, $V_{CE(sat)}$	I_{DSS}, $R_{DS(on)}$		Base Drive: 100 nA to 110 mA. When testing J FETs the base terminal is shorted to the emitter terminal. Collector Sweep: three fixed ranges; 2 V, 5 V, and 20 V peak. Short circuit currents on these ranges are 1.5 A, 2 A, and 150 mA, respectively.
4	Same as #3			
5	I_{CEO} or I_{CES}, I_{CER} with external short or resistor			Voltage Supply: 1 V to 500 V dc. Leakage current measurements to 0.5 mA. The most sensitive deflection factor is 1 nA/div.
6	I_{CBO}	I_{GSS}		Same as #5
7	I_{EBO}		I_R	Same as #5
8	$V_{(BR)CEO}$ or $V_{(BR)CER}$ with external resistor		V_F	Current Supply: 100 nA to 11 mA dc for breakdown voltage measurements to 500 V. Up to 100 mA dc for breakdown voltage measurements to 50 V.
9	$V_{(BR)CES}$	BV_{GSS}		Same as #8.
10	$V_{(BR)CBO}$	BV_{GSS}:		Same as #8.
11	$V_{(BR)EBO}$		V_R	Same as #8.

*1 *All of the test conditions for Test 1 are controlled by the 576 front-panel controls. Test 2 has the same conditions as Test 1 except the horizontal amplifier is connected to the emitter-base terminals, and the horizontal deflection factor is controlled by the programming card.*

For the remaining test the only 576 controls that are functional are the Polarity and CRT controls such as Intensity, Focus, Display Offset.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	198	7.8
Height w/cover	165	6.5
Depth	315	12.4
Weights	**kg**	**lb**
Net	5.2	11.5
Shipping ≈	8.2	18.0

INCLUDED ACCESSORIES

Protective cover (337-1194-00); five programming cards (016-0198-00); 250 programming card pins (214-1633-00); five CRT overlay limit cards (016-0510-00); instruction manual.

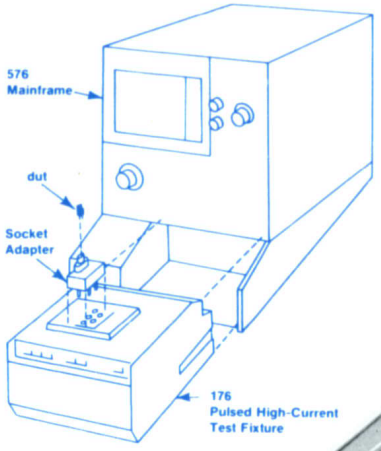
Order 172 Programmable Test Fixture **$4,515**

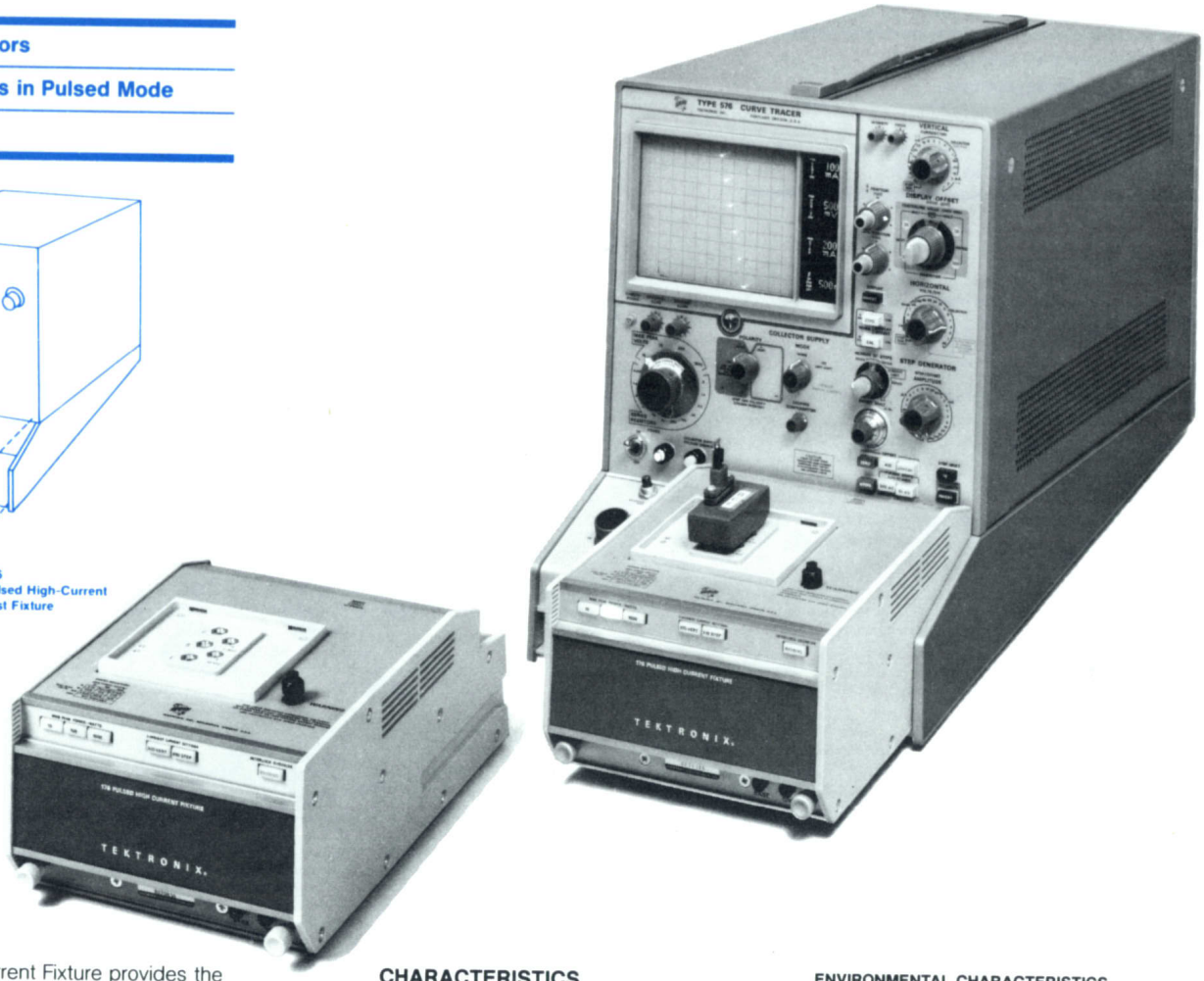
176

Tests Power Transistors

Tests Up to 200 Amps in Pulsed Mode

1000 Watt Capability





The 176 Pulsed High-Current Fixture provides the 576 Curve Tracer with pulsed collector operation to 200 amps peak and pulsed base steps to 20 amps peak. When selected, the step offset is also pulsed. The pulsed operating mode allows many tests previously considered impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without overdissipation. The 176 Test Fixture fits in place of the 576 Standard Test Fixture. The collector pulse is slaved to the 576 in regard to width and repetition rate.

The pulse width is selected by pressing the 300 μs or 80 μs pushbutton on the 576 Mainframe (usually, 300 μs should be selected). The repetition rate is automatically set when the 176 is inserted in the mainframe. Repetition rate is also dependent on power-line frequency. The five highest Vertical Current/Div settings (0.1 A/div to 2 A/div) of the 576 can be multiplied X10 by actuation of the X10 Vert pushbutton on the 176. This feature enables viewing of up to a 200 amp peak display. The five highest Step Generator Amplitude base current steps of the 576 (10 mA to 200 mA) can be multiplied X10 by actuation of the X10 Step pushbutton on the 176. This feature enables the pulsed base step generator on the 176 to provide up to a 20 amp base step (tenth step). Both X10 Vert and X10 Step pushbuttons provide inputs to the fiberoptic readout to display actual values.

CHARACTERISTICS

COLLECTOR SUPPLY (PULSED)

Width — 300 μs or 80 μs determined by 576.
Repetition Rate — Power-line frequency.
Polarity — + or − determined by 576 polarity control.
Amplitude — Ranges are 15, 75, 350 V nominal, controlled by Max Peak Volts switch on 576. Current (minimum available at low line into shorted load) is 15 V range, 200 A; 75 V range, 40 A; 350 V range, 8 A.
Maximum Peak Watts — Three illuminated pushbuttons select 10, 100, 1000 W maximum peak power.

STEP GENERATOR

Current Ranges (X10 Step Selected) — Step-Offset Amplitude Range: 100 mA to 2 A, 5 steps in a 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): X200 576 Amplitude setting or 20 A, whichever is less. Maximum Voltage (Steps and Aiding Offset): At least 5 V up to 10 A and 2 V up to 20 A.
576 Offset Multiplier — 0 to X100 576 Amplitude switch setting.
Step Rate — Power-line frequency.
Pulsed Steps — 300 μs or 80 μs wide.
Step/Offset Polarity — The Step Gen polarity is the same as the Collector Supply polarity. Step polarity may be inverted by actuating the Invert pushbutton.
Accuracy (Current Steps Including Offset) — Incremental: Within 5% between any two steps; within 10% with X0.1 Step Mult. Absolute: Within 3% of total output ±1% of one step or within 3% of one step, whichever is greater.

VERTICAL AMPLIFIER

Deflection Factor (X10 Vert Selected) — 1 A/div to 20 A/div, 5 steps in a 1-2-5 sequence.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Performance characteristics are valid over a temperature range of 0°C to +40°C.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	201	7.9
Height	117	4.6
Depth	290	11.4
Weights	**kg**	**lb**
Net	5.8	12.8
Shipping ≈	8.2	18.0

INCLUDED ACCESSORIES

TO36 adaptor (013-0112-00); stud diode adaptor (013-0110-00); protective shield (337-1194-00); instruction manual.

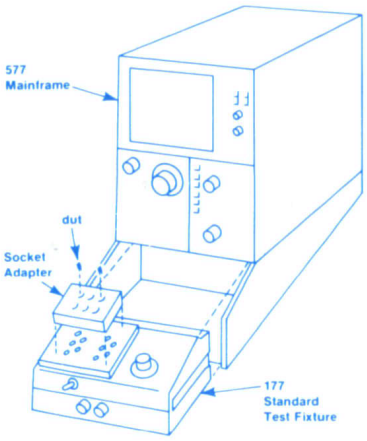
Order 176 Pulsed High-Current Fixture **$5,105**

577

Test Two- and Three-Terminal Discrete Semiconductors

Storage Capability

Power Capability Up to 100 W



The 577 Curve Tracer System, when used with the 177 Standard Test Fixture, is a smaller and lighter configuration that retains many of the important features and performance of the 576. The 577 also accepts the 178 Linear IC Test Fixture. The major features that separate the 577 from the 576 are a storage CRT and the emphasis on low current measurements with the 577.

The 577's storage CRT may be used to overlay the characteristic curves of one device on top of the stored characteristics of another. Dot displays (generated during high current pulsed testing or during very low current testing under dc conditions) can be transformed into complete characteristic curves by simply moving them across the CRT while in the storage mode. A good example of a dot display occurs in op amp testing because the open-loop, 3 dB bandwidth of many op amps is so low that the curves must be plotted slowly. Linear ICs such as op amps may be tested with the 577 by using the 178 Linear IC Test Fixture (see Alphanumeric Index).

In the 577/177 Curve Tracer System, several features facilitate low current measurements. They include: small current sensing resistors (which result in less capacitive looping), current sensing that always takes place in the collector supply lead (which permits measurements on three-terminal active devices at the lowest current ranges and eliminates the need for a correction to the horizontal deflection factor), and a display filter (which reduces vertical deflection noise).

Although the 577/177 Collector Supply has lower power capability (the 576 can deliver approximately 2.2 times as much power to the device under test), approximately the same test current is available; 10 amps continuous peaks at line frequency. The 577/177 provides its highest currents at a lower voltage than does the 576.

Other innovations in the 577/177 Curve Tracer are an emitter-base breakdown position on the lead selector switch, availability of approximately 95 steps from the step generator, an uncalibrated bias supply, independent magnifiers that increase resolution on either or both CRT axes, and a beam finder.

CHARACTERISTICS

All characteristics are for the 577 Curve Tracer Mainframe operating with a 177 Standard Test Fixture.

COLLECTOR SUPPLY

Modes — Five modes of collector supply operation are selectable. These are: ac at line frequency, positive full wave rectified, negative full wave rectified, positive dc, or negative dc.

Voltage[*1]

Max Peak Volts Open Circuit	6.5 V	25 V	100 V	400 V	1600 V
Continuous Current, Peak	10 A	2.5 A	0.6 A	0.15 A	0.04 A
Peak Pulse Current	20 A	5 A	1.25 A	0.30 A	0.08 A

*[*1] The voltage is variable to the maximum peak volts selected.*

Series Resistance — 14 values from 0.12 Ω to 8 MΩ. Coupling of series resistance and voltage controls maintains maximum peak power to the device under test when changing voltage ranges.

Safety Interlock — Protects operator from 100 V, 400 V, and 1600 V ranges. Momentary button provides for overriding interlock.

STEP GENERATOR

Current Mode — Step Amplitude Range: 5 nA/step (with Step X0.1) to 200 mA/step, in a 1-2-5 sequence. Available Current: At least 2 A on the highest amplitude setting with 5 V or more compliance. For opposing offset, available current is at least 10 mA with voltage limited between 1 V and 5 V.

Voltage Mode — Step Amplitude Range: 5 mV/step (with Step X0.1) to 2 V/step, in a 1-2-5 sequence. Current: Limited between 100 mA and 200 mA. For opposing offset, available current is at least 10 mA (at 0 V) derating to 0 mA at 20 V.

Accuracy — Incremental: Within 2% between steps. Absolute: Within 3% of total output or Amplitude setting, whichever is greater. When Step X0.1 is actuated the absolute step accuracy is 4%.

Step Rate — Selectable at X1 (Slow), X2 (Norm), or X4 (Fast) line frequency.

Pulsed Steps — Steps can be gated for a duration of ≈300 μs for testing at low duty cycle.

Step/Offset Polarity — With Norm Polarity selected, the Step Generator polarity is the same as the Collector Supply polarity, and positive in the ac position. Polarity can be independently inverted with Step/Offset Polarity control or from the test fixture.

Offset — The amplitude of the entire set of steps can be offset in a continuously variable and calibrated manner to either Aid or Oppose steps. Maximum range of offset is 10 full-amplitude steps.

Step Family — Repetitive or single family.

Number of Steps — Selectable from 1 to 10 full-amplitude steps. Selectable up to ≈95 steps when using Step X0.1 multiplier.

DEFLECTION CONTROLS

Display Accuracies[*1]

Display Mode	Normal	Magnified
Vertical Collector Current	3% ± 1 nA	4% ± 1 nA
Horizontal Collector Volts	3%	4%
Horizontal Base Volts	3%	4%
Horizontal Step Gen	4%	5%

*[*1] As a percentage of highest on-screen value.*

Vertical Deflection Factor — Collector Current: 2 nA/div to 2 A/div, 28 steps in 1-2-5 sequence (0.2 nA/div to 0.2 A/div with X10 magnification).

Horizontal Deflection Factor

Collector Volts: 50 mV/div to 200 V/div, 12 steps in a 1-2-5 sequence (5 mV/div to 20 V div with X10 magnification).

Base Volts: −50 mV/div to 2 V/div, 6 steps in a 1-2-5 sequence (5 mV/div to 0.2 V/div with X10 magnification).

Step Generator: 1 step/div (0.1 step/div with X10 magnification).

Automatic Scale Factor Readout — Change in deflection factor is indicated by lights behind the knob skirt when using X10 Mag.

Automatic Positioning — Trace (or spot) is automatically positioned when Collector Supply polarity is changed when using the 177.

Display Invert — Single control inverts display and repositions trace.

Display Filter — Selectable low pass filter reduces vertical noise for easier high sensitivity measurements.

CRT

CRT — Rectangular 165 mm (6.5 in) with an 8 x 10 division (1.27 cm/div) parallax-free internal graticule. Two display modules are available for the 577. The D1 display unit has a split-screen storage CRT with phosphor similar to GJ (P1). The D2 display unit has a nonstorage CRT with GH (P31) Phosphor standard. Accelerating potential is 3.5 kV.

Beam Finder — Compresses off-screen trace to within graticule area.

Ambient Temperature Range — Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

PHYSICAL CHARACTERISTICS

	577		177	
Dimensions	**mm**	**in**	**mm**	**in**
Width	224	8.8	201	7.9
Height	503	19.8	102	4.0
Depth	584	23.0	152	6.0
Weights	**kg**	**lb**	**kg**	**lb**
Net	18.1	40.0	1.1	2.5
Shipping ≈	22.7	50.0	2.7	6.0

Note: When the 577 and 177 are ordered together their combined shipping weight is: domestic ≈24 kg or ≈53 lb.

177 Standard Test Fixture

CHARACTERISTICS

Device Lead Selection — Switch provides six different lead configurations. Three positions for Emitter Grounded measurements provide Step Gen, Open (or Ext), and Short base terminal connections. Two positions for Base Grounded measurements provide Step Gen and Open (or Ext) emitter terminal connections. One position provides for Emitter Base Breakdown or leakage measurements up to 25 Vs.

Left-Right Switch — Selects left or right test connections. Off in center position. Test connection area accepts all Tektronix Curve Tracer adaptors and protective cover. Kelvin connections are provided for emitter and collector terminals.

Looping Compensation — Reduces display loops due to test adaptor capacitance and some device capacitance.

Variable Voltage Supply — Continuously variable bias supply from −12 V to +12 V. Source resistance is 10 kΩ or less.

POWER REQUIREMENTS

Line Voltage Ranges (±10%) — 100 V ac, 110 V ac, 120 V ac or 200 V ac, 220 V ac, 240 V ac.

Line Frequency — 50 Hz to 60 Hz.

Power — 155 W max at 110 V ac, 60 Hz.

INCLUDED ACCESSORIES

Transistor adaptor for most bipolar transistors and some MOS FETs (013-0098-02); axial lead diode adaptor with Kelvin sensing terminals (013-0111-00); protective shield for test connection area (337-1194-00); instruction manual.

ORDERING INFORMATION

577/D1 Storage Curve Tracer Mainframe **$5,985**

577/D2 Nonstorage Curve Tracer Mainframe **$5,165**

Option 10 — 10 x 10 cm graticule; available with either storage or nonstorage mainframe ..... +**$50**

177 Standard Test Fixture **$1,230**

OPTIONAL ACCESSORIES

178 — Linear Test Fixture. (See page 414.) **$3,080**

Test Setup Chart — Package of 250. Order 070-1639-00 ..... **$7.50**

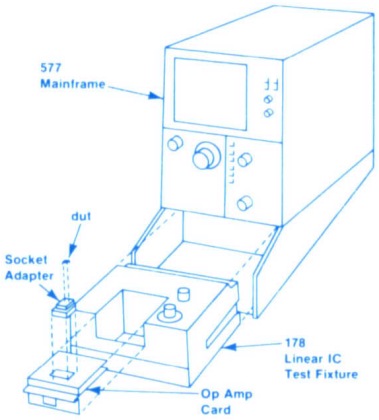
Device Adaptor Sockets — (See page 416.)

C-5C — Camera **$530**

Model 3 Tek Lab Cart **$560**

178

**Tests Single, Dual, or Quad:
Operational Amplifiers, Comparators
Differential Amplifiers, Regulators and More**



Since linear ICs are typically tested under very low current conditions, the 577/178 Curve Tracer System is ideally suited to the task. The 178 Linear IC Test Fixture provides the necessary and accurate low-current measurement capability. Test cards set up the measurement function, and the 577's storage CRT allows the operator to transform the dot display (usually seen under low current dc conditions) into a complete characteristic curve by slowly sweeping the dot across the CRT while in the Storage Mode.

A 577/178 Curve Tracer System is composed of a 577 Mainframe, 178 Linear IC Test Fixture, appropriate test cards (choose from three op amp cards and two regulator cards), and the proper socket adaptor that interfaces the system to the device under test.

Test cards, which slide into the 178, define the measurement function of the 178 Test Fixture. Two families of test cards are available: op amp cards and regulator cards. Op amp cards are used for testing standard and special op amps, comparators, differential amplifiers, video amplifiers, etc. Regulator cards are used for testing positive and negative three-terminal voltage regulators.

OP AMP CARDS

The Standard Op Amp Card is designed to test devices that require single or dual power supplies, have two (differential) high-impedance inputs, and a single output. Common measurements include: offset voltage, positive and negative input current, CMRR, gain, positive and negative psrr, positive and negative supply current, and collector supply current.

The Hardwire Card is designed for those applications where there is an advantage in preparing individual cards for specific devices so that they may be quickly switched to accommodate a change in the type of device under test. The Hardwire Card also offers a greater degree of freedom to the knowledgeable designer in testing special devices.

The Multiple Op Amp Card allows the operator to test up to four devices in a single package by simply operating a four-position switch. The four-position switch selects the op amp (in a multiple op amp package) or the selection of a linear IC to be tested. The measurements performed are the same as those available with the Standard Op Amp Card.

Socket Adaptors for Op Amp Cards

The device under test socket on the Standard and Multiple Op Amp Cards accepts several types of socket adaptors using the Amphenol-Barnes Adaptor System. This system accepts most of the standard package configurations (TO5, DIP, flat pack, etc). Sockets for these cards are shown on the last page of this section.

REGULATOR CARDS

There are two types of Regulator Cards, positive and negative. These cards are used primarily in measuring parameters of three-terminal voltage regulators. Parameters measured include: output voltage, load regulation, line regulation and ripple regulation, and quiescent and common terminal current.

Socket Adaptors for Regulator Cards

Socket adaptors for both positive and negative three-terminal regulators are the same as the Kelvin Sensing Adaptors used on the standard curve tracer. (See the last page of this section.)

CHARACTERISTICS

Vertical Deflection*1	Normal	Magnified
Input Voltage or ΔInput Voltage	10 μV/div to 50 mV/div	1 μV/div to 5 mV/div
Accuracy*2	3%	4%
Input Current	50 pA/div to 0.2 mA/div	5 pA/div to 20 μA/div
Accuracy*2	3% ±50 pA	4% ±50 pA
Power Supply Current	0.1 μA/div to 50 mA/div	10 nA/div to 5 mA/div
Accuracy*2	3% ±0.1 μA	4% ±0.1 μA
Collector Supply Current	1 nA/div to 50 mA/div	0.1 nA/div to 5 mA/div
Accuracy*2	3% ±1 nA	4% ±1 nA

*1 *1-2-5 sequence.*
*2 *Percentage of highest on-screen values.*

Power Supplies — Positive and negative supplies are adjustable from 0 to 30 V; available current is at least 150 mA with adjustable current limiting. The voltage of both supplies can be adjusted from a single calibrated control; accuracy is within 2% ±100 mV. Negative supply can be independently adjusted by an uncalibrated control.

Sweep Generator — A sinusoidal signal controls the output, common-mode input, or the power supply voltages of the device under test. Frequency: Adjustable from 0.01 Hz to 1 kHz. Amplitude: Adjustable up to 30 V peak.

Source Resistance — For input resistor pairs, selectable 50 Ω 10 kΩ, 20 kΩ, and 50 kΩ, or external resistors may be used. When the vertical deflection factor is in one of the less sensitive positions, 1 mV through 50 mV/div, the input resistance values are 550 Ω greater.

Load Resistance — Six selectable load resistors, 100 Ω, 1 kΩ, 2 kΩ, 5 kΩ, 10 kΩ, 20 kΩ, and 50 kΩ, or external resistors may be used.

Collector Supply — The 25 V and 100 V ranges of the collector supply (located on 577 Mainframe) are available to the 178 Test Fixture. Supply output is located on the 178 front-end panel and on the device card. Automatic positioning with supply polarity is inoperative when using the 178 Test Fixture. (See 577/177 characteristics for collector supply performance.)

Step Generator — All the capabilities of the step generator (located on 577 Mainframe) are available to the 178 Test Fixture. Generator output is located on the 178 front-end panel and on the device card. (See 577/177 characteristics for step generator performance.)

DUT Supplies Disconnect — A single switch disconnects all power to the device under test; both plus and minus power supplies, collector supply, and step generator.

Function Switch — Selects vertical and horizontal deflection signals and connection of the test signal to the device under test.

Zero — Single pushbutton provides a zero reference to the CRT display and in certain functions, nulls out offset voltage in order to measure Δinput V on the vertical display axis.

THREE-TERMINAL REGULATOR TEST CARD CHARACTERISTICS

Device Under Test Input Supply

Input Voltage: Two ranges 0 to 30 V and 0 to 60 V. 0 to 30 V: Within ±2% ±200 mV of dial setting. 0 to 60: Within ±2.5% ±300 mV of dial setting.

Regulation — Within 200 mV.

Input Sweep Frequency — Dc to 1 kHz.

300 μs Pulsed Current — 5 mA to 2 A.

Short Duration Dc Current*1

Supply Voltage	Current
0 to 10	700 mA
10 to 20	350 mA
20 to 40	350 mA
40 to 60	120 mA

*1 *One minute duration.*

Device Under Test Current Load — 5 mA to 2 A within ±3% of 0 to 1.25 mA.

Device Under Test Comparison Output Dc Voltage Accuracy — 0 to 10 V range within ±1% ±20 mV. 0 to 100 V range within ±1% ±150 mV.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	201	7.9
Height	114	4.5
Depth	198	7.8
Weights	**kg**	**lb**
Net	1.5	3.3
Shipping ≈	3.6	8.0

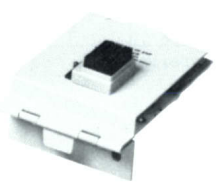
INCLUDED ACCESSORIES

16 DIP IC sockets (136-0442-00); standard Op Amp Card with cover and ten patch cords (013-0149-02); interchangeable nomenclature panel for function switch (333-1770-00); instruction manual.

Order 178 Linear IC Test Fixture **$3,080**

OPTIONAL ACCESSORIES

Standard Op Amp Card — One included with 178.
Order 013-0149-02 ..... **$165**
Hardwire Card — Order 013-0150-02 ..... **$110**
Multiple Op Amp Card — Order 013-0155-01 ..... **$595**
Positive Regulator Card — Order 013-0147-00 ..... **$995**
Negative Regulator Card — Order 013-0148-00 ..... **$995**



Standard Op Amp Card

Positive Regulator Card

5CT1N/7CT1N

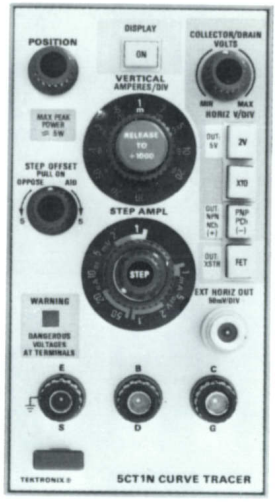
Tests Semiconductor Devices to 0.5 W

10 nA/div to 20 mA/div Vertical Deflection Factors

0.5 V/div to 20 V/div Horizontal Deflection Factors

Easy to Operate

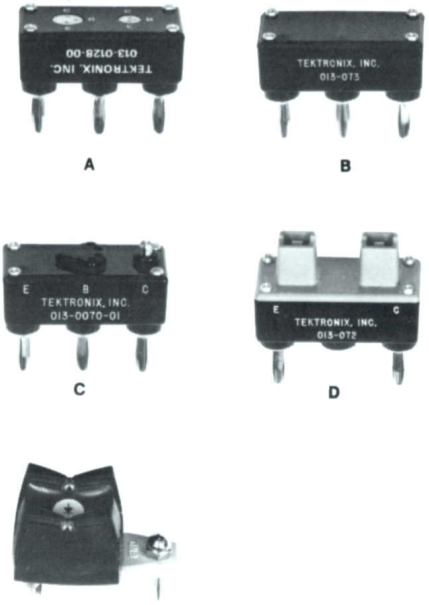
5CT1N



Curve Tracer

7CT1N

Curve Tracer



The 7CT1N Curve Tracer is a plug-in unit for use in Tektronix 7000 Series Oscilloscope Systems and the 5CT1N Curve Tracer is a plug-in unit for use in Tektronix 5000 Series Oscilloscope Systems. Both are for displaying characteristic curves of small-signal semiconductor devices to power levels up to 0.5 watts. The plug-ins operate in a vertical compartment of the respective mainframes. The 7CT1N also operates in the horizontal compartments of the 7000 Series Oscilloscope Systems.

CHARACTERISTICS

COLLECTOR/DRAIN SUPPLY

	X1		X10	
Horizontal Volts/Div	0.5	2	5	20
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V
Maximum Current	240 mA	60 mA	24 mA	6 mA

Maximum Open Circuit Voltage — Within ±20%. Maximum short circuit current within 30%.

Series Resistance — Automatically selected with horizontal V/div switches. Peak Power: 0.5 W or less depending upon control settings.

High Voltage Warning — When the horizontal V/div switch is in the X10 position, a flashing warning light appears on the front panel indicating that dangerous voltages may exist at the test terminals.

STEP GENERATOR

Transistor Mode — Step Amplitude Range: 1 μA/step to 1 mA/step, 1-2-5 sequence. Maximum Current (Steps Plus Aiding Offset): X15 amplitude setting. Maximum Voltage (Steps Plus Aiding Offset): At least 13 V. Maximum Opposing Offset Current: At least X5 amplitude setting.

FET Mode — Step Amplitude Range: 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage Amplitude (Steps Plus Aiding Offset): X15 amplitude setting, 13 V maximum. Source Impedance: 1 kΩ ± 1%.

Accuracy
Incremental: Within 3% between steps.
Absolute: Within ±(3% + X0.3 amplitude setting).

Step Polarity — The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

Number of Steps — Selectable in one-step increments between 0 and 10.

Offset — Selectable from 0 to 5 steps. Polarity aids or opposes the step polarity.

Vertical Deflection Factors — 10 nA/div to 20 μA/div with the ÷1000 control activated. 10 μA/div to 20 mA/div in the X1 mode.

Vertical Display Accuracy — Within 5% in the X1 mode. Within 5% ±0.2 nA per displayed horizontal V when in the ÷1000 mode.

Horizontal Deflection Factors — Selectable, 0.5 V, 2 V, 5 V, or 20 V.

5CT1N Horizontal Display Accuracy — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the Tektronix 5000 Series plug-ins) with a 50 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of the 5000 Series Oscilloscope Mainframe.

7CT1N Horizontal Display Accuracy — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the Tektronix 7000 Series plug-ins) with a 100 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of the 7000 Series Oscilloscope Mainframe.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Performance characteristics are valid from 0°C to +50°C.

PHYSICAL CHARACTERISTICS

	5CT1N		7CT1N	
Dimensions	**mm**	**in**	**mm**	**in**
Width	66	2.6	71	2.8
Height	127	5.0	127	5.0
Depth	305	12.0	368	14.5
Weights	**kg**	**lb**	**kg**	**lb**
Net	0.8	1.8	1.1	2.5
Shipping ≈	1.8	4.0	2.7	6.0

INCLUDED ACCESSORIES

Test Adaptor with two sets of test terminals, one with TO5 basing and the other with TO18 basing (013-0128-00); instruction manual.

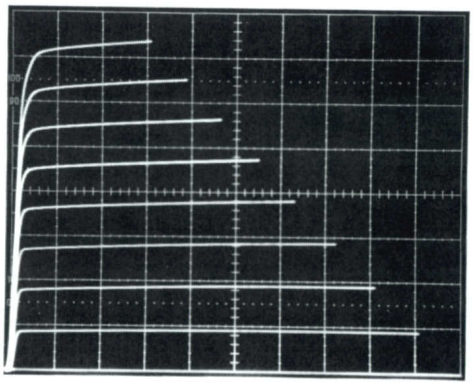
ORDERING INFORMATION

5CT1N Curve Tracer **$900**
7CT1N Curve Tracer **$1,470**

3-PIN ADAPTORS

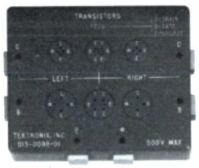
The following 3-pin adaptors may be used with any of the Tektronix Curve Tracer products. They do not have Kelvin sensing contacts.

A. TO5 or TO18 — Transistor Adaptor.
Order 013-0128-00 ..... **$32**
B. Blank Adaptor — For mounting special sockets.
Order 013-0073-00 ..... **$19**
C. TO3 or TO66 — Transistor Adaptor.
Order 013-0070-01 ..... **$40**
D. Diode Test Adaptor — Holds axial-lead diodes.
Order 013-0072-00 ..... **$74**
E. Diode Test Adaptor — Magnetically holds steel axial-lead diodes. Order 013-0079-00 ..... **$220**



2N3904 transistor characteristic generated by the 7CTIN. Control Settings are indicated on front panel of 7CTIN.
Vertical: 2 mA/division
Horizontal: 0.5 V/division
Base Current: 10 μA/step

TEK CURVE TRACER SOCKET ADAPTORS



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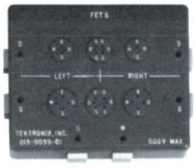

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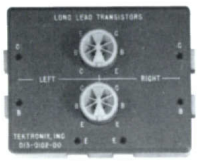

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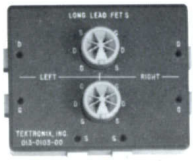

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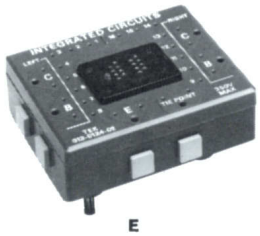

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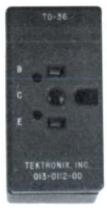

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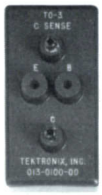

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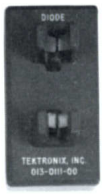

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DUAL WIDTH ADAPTORS

The following accessories fit the side-by-side terminals on test fixtures of the 576, 576/172, and 577/177 Curve Tracers.

A. Transistor Adaptor — Useful for most single and dual bipolar transistors and some MOS FETs.
Order 013-0098-02 ..... **$220**

B. FET Adaptor — Useful for most single and dual FETs.
Order 013-0099-02 ..... **$220**

C. Long Lead Transistor Adaptor — Accepts dual or single transistors with untrimmed leads.
Order 013-0102-00 ..... **$210**

D. Long Lead FET Adaptor — Accepts dual or single FETs with untrimmed leads.
Order 013-0103-00 ..... **$240**

E. Integrated Circuit Adaptor — Allows connection to multipin device packages. The appropriate multilead socket is plugged into the integrated circuits adaptor. The pins are then connected to the collector, base, or emitter terminals by means of the patch cord. A tie point is also provided so that an external power supply or signal source may conveniently be patched to the IC pins. Order the appropriate multilead socket listed separately.
Order 013-0124-03. Includes 10 each 4 inch test leads **$430**

KELVIN SENSING ADAPTORS

The following accessories fit the test fixtures of the 576, 576/172, 576/176, and 577/177 Curve Tracers.

A. Transistor Adaptor — Accepts long or short transistors. Can be rewired to accommodate nonstandard configurations.
Order 013-0127-01 ..... **$85**

B. In-Line Adaptor — Accepts large and small transistors with in-line leads. The adaptor will accept devices with approx spacing between terminals of 0.06 in up to 0.18 in. It is wired for a B-C-E terminal configuration but may be easily rewired for the C-B-E configuration.
Order 013-0138-01 ..... **$100**

C. TO36 Adaptor — Order 013-0112-00 ..... **$100**

D. TO3 Adaptor — Can be rewired to accommodate nonstandard configurations. Order 013-0100-01 ..... **$115**

E. TO66 Adaptor — Order 013-0101-00 ..... **$115**

F. Axial Lead Diode Adaptor —
Order 013-0111-00 ..... **$95**

G. Stud Diode Adaptor — Order 013-0110-00 ..... **$100**

H. Blank Adaptor — For mounting special sockets.
Order 013-0104-00 ..... **$60**

I. Power Transistor Adaptor —
Order 013-0163-00 ..... **$110**

MULTILEAD SOCKETS

These sockets are used with the Integrated Circuit Adaptor (013-0124-01) listed under Dual Width Adaptors, and with the 178 Test Fixture.

A. 8 Lead TO Package — Order 136-0444-00 ..... **$44**

B. 10 Lead TO Package — Order 136-0441-00 ..... **$50**

C. 14 Lead Dual-in-line Package —
Order 136-0443-00 ..... **$50**

D. 16 Lead Dual-in-line Package —
Order 136-0442-00 ..... **$45**

These four sockets are the most commonly required in curve tracer applications. Additional socket configurations, including zero insertion style, are available from Textool Products, Inc., 1410 W. Pioneer Dr., Irving, TX 75061.

DIGITAL PHOTOMETER/ RADIOMETER

CONTENTS

J16 Photometer/Radiometer 417
Illuminance Probes 418
Irradiance Probes 418
Luminance Probes 418
Uncorrected Probe 419
LED Test Probe 419

J16 Photometer/Radiometer

Digital LED Readout

Freedom from Saturation Effects over Entire Range

Metric and US Versions Available

Accurate Spectral and Cosine Corrections

Ac or Internal Rechargeable Battery Versions

Application Notes Available

Eight Silicon Sensor Probes Quickly Interchanged without Recalibration

The Tektronix J16 is a portable digital photometer/radiometer capable of making a wide variety of light measurements—in the laboratory, in the field, or on the production floor.

Eight quickly interchangeable probes are available for measuring illuminance, irradiance, luminance, light-emitting diode output, and relative intensity. Recalibration is not necessary when probes are interchanged. Connection of a probe to the J16 automatically selects the correct front panel units indicator. The 3½-digit LED display can be easily read under low ambient conditions. All probes use silicon photo-diodes and multi-element glass filters for maximum stability and accuracy. The excellent stability eliminates the need for routine zero adjustments.

Integrated circuits are used extensively in the J16 to achieve stable operation, low power requirements, small size, and low weight.

Under normal usage, internal rechargeable nickel cadmium batteries will only need recharging weekly. A battery charger is supplied. An ac power supply is available that replaces the battery pack for continuous operation.

A shoulder strap provides carrying ease. The cabinet and probes have a standard threaded socket (¼ inch x 20) for convenient mounting on a tripod or optical bench.

J16-TV Package

The J16-TV is an excellent transfer mechanism which provides a simple, accurate method for adjustment of monitor screen color temperature. The primary colors are measured and adjusted to produce white color temperature balance.

The J16-TV with optional J6503 or J6523 measures monitor screen brightness on both color and black and white monitors. Other applications include measurement of studio lighting, camera lighting, and illumination of work areas.

The J16-TV package includes: J16 Battery-operated Photometer, J6502 Irradiance Probe, light occluder, probe extension cable, and battery charger.

J6501
J6502
J6503
J6504
J6505

J6523

LED ADAPTOR
(included with J6505)
014-0047-00

J6511
J6512

42 IN PROBE EXTENDER CABLE
012-0414-02

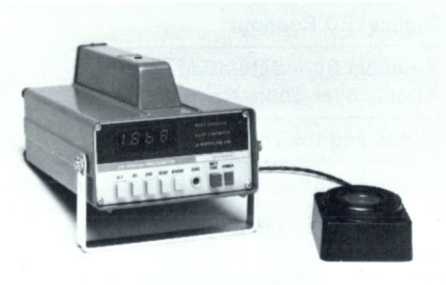
J6511 and J6501 Illuminance Probes

The J6511 is an illuminance probe with readout in footcandles (lumens/m^2 (lux) for the J6511 Option 02). A multi-element glass filter and silicon photo-diode insure a close match to the CIE photopic curve (color corrected). The silicon-sensor recovery time is virtually instantaneous; low light levels can be measured immediately after exposure to bright sunlight.

The angular response is accurately cosine corrected, simulating an ideal 180° field-of-view detector. The low-profile probe has a leveling indicator to assure accurate measurements where a significant proportion of the illumination comes from sources at low angles to the horizon.

A 25-foot cable between the probe and J16 allows the user to be out of the field of view while making measurements. Typical applications include measurement of roadway illumination, office lighting, and illumination of work surfaces.

Where cosine correction is not necessary, a standard probe is available (J6501) with the same photopic correction and units as the J6511.



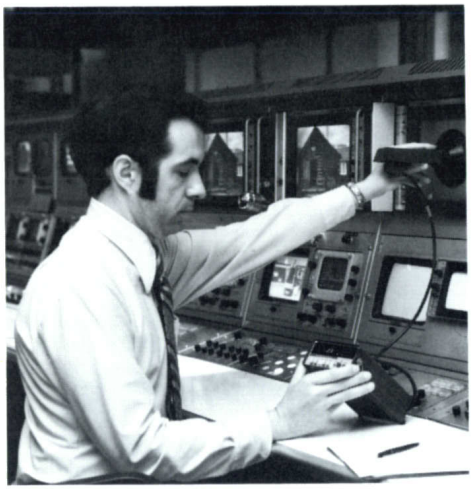
The low-profile J6512 shown above is physically similar (without cosine correction) to the J6511.

J6502 and J6512 Irradiance Probes

The J6502 measures irradiance in microwatts/cm^2 (millwatts/m^2 for the J6502 Option 02). The spectral response is flat from 450 to 950 nanometers, ±7%. The response is typically down 50% at 400 and 1030 nm. Typical applications include laser research experiments and measurements of radiant efficiency.

An optional filter holder is available to mount standard 1-inch diameter customer-supplied filters of up to 3/8 inch thickness. Where high intensity sources are used (over 1990 μwatts/cm^2), neutral density filters can be used to extend the range of the J16. (An ND 1 filter has 10% transmission, an ND 2 filter has 1%, etc.). These filters may be held with optional filter holders.

Where the 1 sq cm sensor is not completely filled by the source for example with a laser beam, the reading obtained represents μwatt instead of μwatts/cm^2 (J6502), or milliwatts x 10^{-4} instead of milliwatts/m^2 (J6502 Option 02). Small variations in sensor uniformity may add ±5% uncertainty to this measurement.



J16-TV System being used for color monitor setup.

J6503 8° Luminance Probe

The J6503 measures luminance in footlamberts (candelas/m^2 (nit) for the J6503 Option 02) where light scattered or emitted by a surface must be measured. The probe is pointed at the emitting surface. Typical applications include measuring brightness of television screens and street signs, and light reflected from work surfaces and movie screens.

The probe's response is closely matched to the CIE photopic curve, assuring accurate results even when measuring spectrally different light sources.

The acceptance angle is approximately 8°, which is determined by internal field stop apertures. Providing that the 8° field is uniformly filled, the probe can be held at any distance from the source. At 21 inches from the front of the probe, the field of view is approximately three inches in diameter. The footlambert or candelas/m^2 (nit) (J6503 Option 02) indicator automatically lights when the J6503 is connected.

Measuring Luminance with the Tektronix J16/J6523.

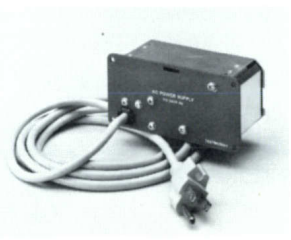
J6523 1° Luminance Probe

The J6523 will measure the luminance in footlamberts (candelas/m^2 for the J6523 Option 02) of a spot as small as 0.32 inches in diameter (0.035 inches with standard set, +10 diopters, 55 mm photographic close-up lens). The 1° angle represents 0.21 inches per foot of distance from the probe to the source. Thus at 10 feet, the J6523 measures a 2.1-inch diameter spot. Typical applications include measuring highway lighting, television displays and photographic equipment.

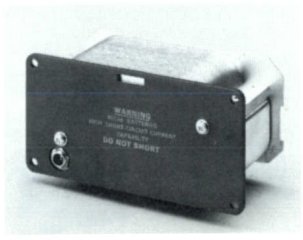
The probe includes an optical sighting system with a 9° viewing field. The focusing range is 18 inches to infinity, closer with commercially available, stackable, 55 mm close-up lenses. The spectral response is closely matched to the CIE photopic curve (color-corrected) for accurately measuring all commonly used light sources.

The J6523 may be attached to the J16 or used with an optional probe extension cable. A standard 1/4-20 threaded socket allows it to be used on a tripod or an optical bench.

AC POWER SUPPLY



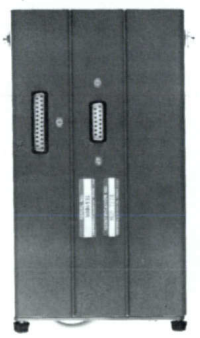
BATTERY PACK



BATTERY CHARGER

ANALOG/ BCD OUTPUT CONNECTOR →

MODIFIED J16 WITH ANALOG/BCD OUTPUT



J6504 Uncorrected Probe

This probe is designed for applications where only relative measurements need be made. The J6504 has the widest spectral range, and is the most sensitive probe. Use is made of a UV-enhanced silicon sensor and a UV-transmitting window rather than spectral-correction filters. The J6504 is useful for checking light sources used in photo-resist or photoprocessing applications and comparisons of ultraviolet light sources.

A Hold switch allows the reading to be stored at any time. No units are indicated on the three front panel indicators when using the J6504, since it provides relative readings only.

An optional filter holder may be used to mount standard 1-inch diameter filters on standard-configuration probes. Ultraviolet, visible, or near infrared filters can be used to select the wavelength of interest and exclude ambient light.

J6505 LED Test Probe

The principal application of the J6505 is measurement of light-emitting diodes (LED) having spectral outputs in the red region (600 to 710 nm). The J6505 measures illuminance in footcandles (lumens/m² (lux) for the J6505 Option 02), which can easily be converted into luminous intensity in candelas.

An adaptor supplied with the probe provides a controlled spacing between the sensor and the LED under test. The adaptor excludes ambient light, and has internal baffles to prevent stray reflections during the measurement. Three inserts are supplied with the adaptor to fit common sizes of LED's (0.080 inch, 0.125 inch, and 0.200 inch in diameter). These inserts are made of soft plastic that can be easily modified by the user.

With the adaptor in place, a reading of 1 footcandle on the J16 represents 100 millicandelas of luminous intensity. With a metric version of the J16/J6505 (Option 02), 1 lumen/m² represents 10 millicandelas. A 10X increase in sensitivity is available on special order.

In the J6505, the silicon photodiode-filter combination provides an excellent match to the photopic curve in the region 600 to 710 nm. This close match requires compromising in the 380 to 600 nm region making this probe unsuitable for general illuminance measurements. For LED measurements in the yellow or green region, the adaptor must be used with the J6501 and the same conversion factor for luminous intensity applies.

PROBE CHARACTERISTICS

Application		Illuminance		Irradiance	Luminance		Uncorrected	Red LED
Probe		J6501	J6511	J6502/J6512	J6503	J6523	J6504	J6505
Range	US*2	0.001 to 1999 footcandles*1	0.001 to 1999 footcandles	0.001 to 1999 microwatts/cm²	0.1 to 199,900 footlamberts*1	0.1 to 19,990 footlamberts*1	Relative response only	0.001 to 1999 footcandles*1†
	Metric (Opt. 02)*2	0.01 to 19,990 lumens/m² (lux)*1†	0.01 to 19,990 lumens/m² (lux)	0.01 to 19.990 milliwatts/m²	1 to 1,999,000 candelas/m² (Nits)*1	1 to 199,900 candelas/m² (Nits)*1	Relative response only	0.01 to 19,990 lumens/m² (lux)*1†
Accuracy (Including J16)		Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100° k tungsten halogen light source traceable to NBS		Same, except calibrated with a 762 nm filter	Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100° k tungsten halogen light source traceable to NBS		Probe-to-probe accuracy ±5% with tungsten light source	Same as J6501, except calibrated with a 656 nm filter
Spectral Response		Within 2% (integrated) of CIE photopic curve		Flat within ±7% from 450 to 950 nm	Within 2% (integrated) of CIE photopic curve		UV enhanced silicon spectral curve (250 to 1200 nm)	Within 2% (integrated) of CIE photopic curve from 600 to 710 nm
Acceptance Angle		50% sensitivity at 48° off axis	Cosine corrected (180°)	50% sensitivity at 48° off axis	8°	1°	50% sensitivity at 48° off axis	
Stability and Repeatability		Within 2% per year						
Linearity		Within 2% over entire range enabling single point calibration						

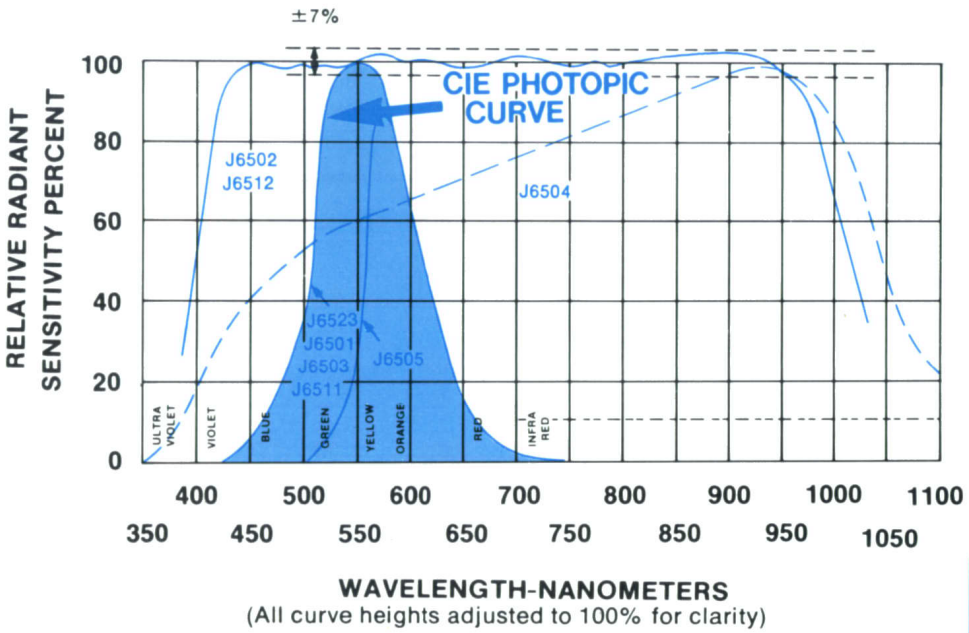
**1 An additional decade of sensitivity is included and is usable if the J16 is carefully zeroed and used at a relatively stable temperature.*

† 0.00001 to 199.9 candelas when used with 014-0047-00 LED adaptor or at 3.8 inches source-to-sensor spacing. Luminous intensity readings of higher intensity light sources may be easily made at correspondingly greater distances using the formula: Footcandles x d²=candelas where d is the distance from the source to the sensor in feet. (For metric readings use lux x d²=candelas where d is distance from the source to the sensor in meters.) Request J16 Application Notes 58A-2635 and 58A-2704-1 for further information.

**2 U.S./METRIC CONVERSIONS*

	U.S. to Metric	*Metric to U.S.*
Illuminance	*Fc x 10.764 = Lux*	*Lux x 0.0929 = Fc*
Luminance	*Fl x 3.426 = Nits*	*Nits x 0.2919 = Fl*

TYPICAL PROBE SPECTRAL CHARACTERISTICS



CHARACTERISTICS (J16)

Display — 3½-digit LED readout and three LEDs automatically indicating correct units for probe in use. Metric version readout is also available (Option 02).

Stability — Within 2% per year.

Linearity — Within 2% over the entire range, enabling single point calibration.

Integration Time — ≈100 ms.

Calibration — Electrical calibration of the J16 is performed by use of a calibrated voltage source or DVM traceable to NBS. Calibrated probes can be used with any J16 without additional calibration.

Power Requirements

Standard and Option 01: Has internal rechargeable NiCd batteries that require 16 hours for a full charge. The J16 will operate two hours on a charge. The J16 cannot be operated from the battery charger for continuous operation since the charging rate is ≈200 mA, while the J16 draws ≈750 mA. For continuous operation an ac power supply is recommended.

Option 03 and Option 04: Ac only operation, no internal batteries.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature — Nonoperating: −50°C to +75°C. Operating: −15°C to +40°C.

Altitude — Nonoperating: To 15 000 m (50,000 ft). Operating: To 4600 m (15,000 ft).

Humidity — Operating and storage, 5 cycles (120 hour) to 95% relative humidity at 40°C. Referenced to MIL-E-16400F.

Vibration — Operating, 15 minutes along each of the 3 major axes at a total displacement of 0.025 in p-p (4 g's) from 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Hold for 3 minutes at 55 Hz. All major resonances must be above 55 Hz.

PHYSICAL CHARACTERISTICS WITH PROBE AND BATTERY PACK INSTALLED

Dimensions	mm	in
Width	123	4.6
Height	60	2.4
Depth	203	8.0
Weights ≈	**kg**	**lb**
Net	1.5	3.3
Domestic Shipping	2.3	5.0
Export-packed	4.5	10.0

INCLUDED ACCESSORIES

Battery Versions — Standard J16 and Opt 01: Battery charger (119-0375-02 or 119-0375-03); shoulder strap (346-0104-00); battery pack (016-0539-01); instruction manual.

Ac Only Versions — J16 Opt 03 and 04: Ac power pack (119-0404-00 or 119-0404-01); shoulder strap (346-0104-00); instruction manual.

J16-TV Versions — Depending on the option, the same accessories listed above plus the items listed in the J16-TV package.

ORDERING INFORMATION

J16 Photometer/Radiometer (Includes 115 Vac, 50 Hz to 400 Hz Battery Charger, Does Not Include Probes) **$1,195**

Option 01 — As above, but includes 230 V ac, 50 Hz to 400 Hz battery charger ..... **NC**

Option 02*[1] — Metric readout for J16 (requires Option 02 probes) ..... **NC**

Option 03 — 115 V ac only operation, 50 Hz to 400 Hz . **NC**

Option 04 — 230 V ac only operation, 50 Hz to 400 Hz . **NC**

BCD and Analog Outputs — A custom modified J16 is equipped with an added 25-pin connector on the cabinet top, providing digital logic and BCD readout outputs, a "hold" input and an analog signal output, for remote data reduction. A mating cable-end connector and connector cover have been added to the accessories complement. Contact your Tektronix representative for price and delivery information.

[1] Option 02 must also be selected for probes.

TELEVISION MEASUREMENTS

J16-TV Photometer/Radiometer Package For TV Color Monitor Setup. The Package Includes J16 Battery-Operated Photometer, J6502 Irradiance Probe, Light Occluder, 42 In Probe Extension Cable **$1,790**

Available with Options 01, 02, 03 and 04 above.

PROBES

J6501 Illuminance Probe **$560**

J6502 Irradiance Probe **$560**

J6503 8° Luminance Probe **$560**

J6504 Uncorrected Probe **$530**

J6505 LED Probe, Includes LED Adaptor **$560**

J6511 Illuminance Probe, Cosine Corrected **$545**

J6512 Irradiance Probe **$550**

J6523 1° Luminance Probe **$1,590**

Option 02 — Metric probes required for metric readout J16's (Option 02) ..... **NC**

Option 05 — Actual spectral curve of any probe (available on initial order) ..... **+$90**

OPTIONAL ACCESSORIES

42 in Probe Extender Cable — Connects J16 and probe. Order 012-0414-02 ..... **$105**

Probe Extender Cables — Up to 30 ft in length. Available on special order through your local Tektronix Sales Office.

Light Occluder — For TV color monitor balancing. Order 016-0305-00 ..... **$20**

Filter Holder — Mounts 1 in diameter filters, of up to ⅜ inch thickness, to probes (except J6511, J6512, J6523). Order 016-0527-00 ..... **$25**

LED Adaptor — Included with J6505. Order 014-0047-00 ..... **$85**

Power packs can be quickly changed by removing four corner screws on the J16's rear panel and sliding the power supply or battery pack out.

Ac Power Supply — Allows J16 to be used without batteries.
Order 119-0404-00 115 V ac, 50 Hz to 400 Hz **$210**
Order 119-0404-01 230 V ac, 50 Hz to 400 Hz **$240**

Spare Battery Pack — Order 016-0539-01 ..... **$140**

When ordering a battery pack for your ac-powered J16, also order one of the following chargers.

Battery Charger — 115 V ac, 50 Hz to 400 Hz. Order 119-0375-02 ..... **$50**

Battery Charger — 230 V ac, 50 Hz to 400Hz. Order 119-0375-03 ..... **$50**

Within the basic limitations of the silicon sensors and the J16 design, a number of modifications are possible. Contact your local Tektronix Sales Office or Representative regarding special application requirements.

J16 APPLICATION NOTES

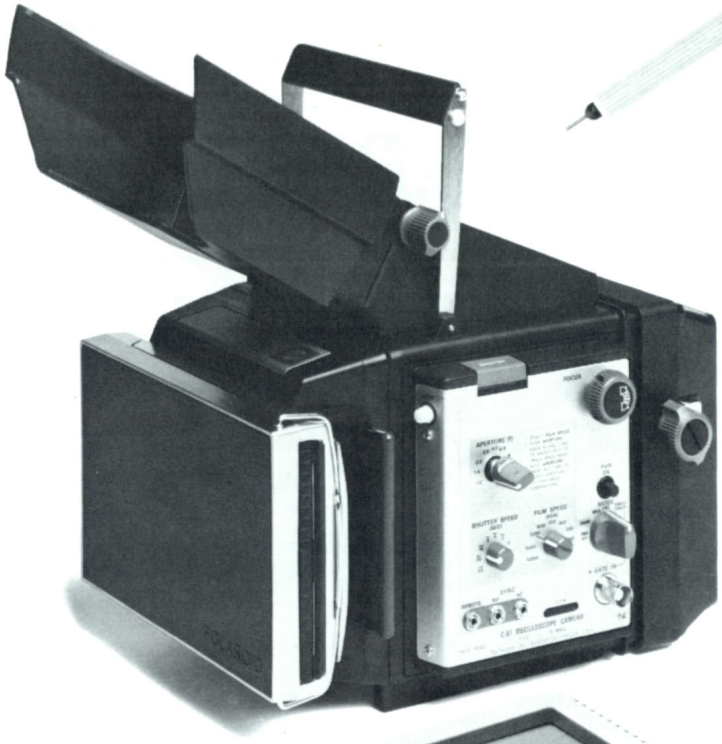
These can be obtained from your local Tektronix representative.

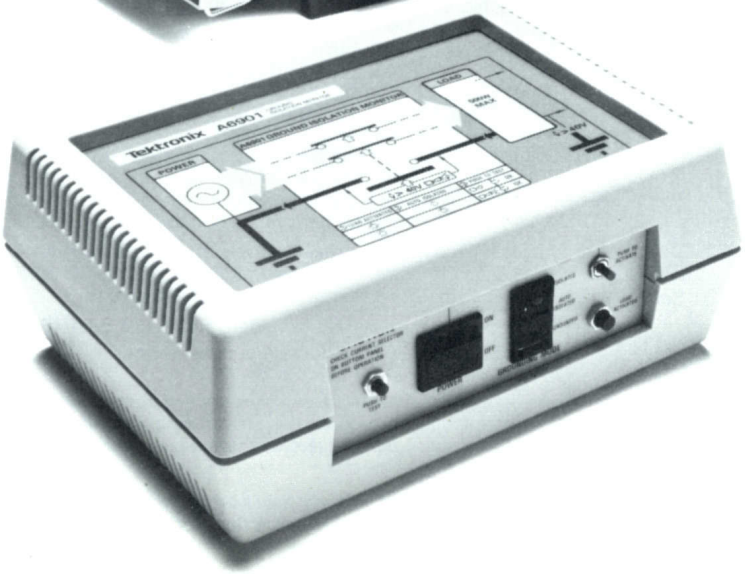
DESCRIPTION	REQUEST NO
Luminous intensity and visible LED measurements with the Tektronix J16 Photometer.	58A-2635
Measuring pulsed light sources with the J16 and an oscilloscope.	58A-2702-1
Radiant intensity and infrared emitting diode measurements.	58A-2704-1
Radiometry and photometry for the electronics engineer.	58A-2578
Television station applications for the J16 Photometer.	58AX-2764-1
Practical lighting measurements with the Tektronix J16.	58A-2912
TV picture monitor color temperature adjustment using the Tektronix J16.	58A-2926-1
Photographic exposure measurements with the Tektronix J16.	58AX-3060-1
Measuring the luminance of small areas of light with the J16 and J6523.	58AX-3252
Optical communications measurements.	58AX-3602

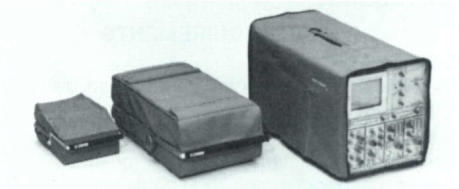
ACCESSORIES

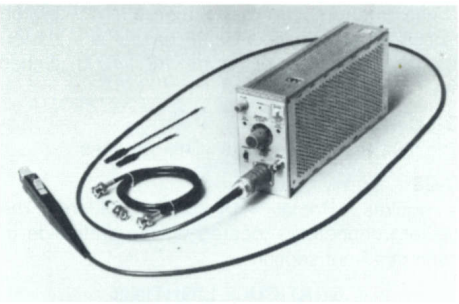
CONTENTS

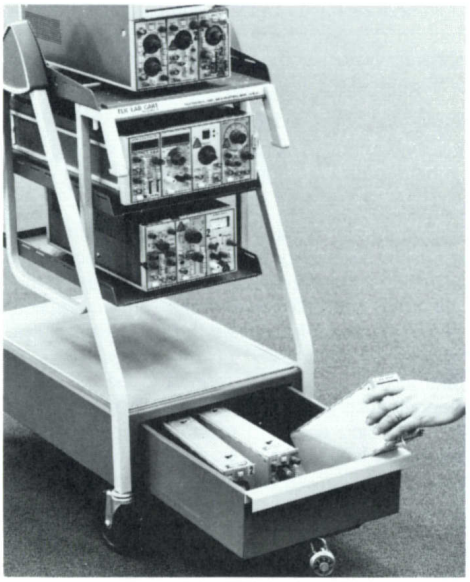
Cameras & Adaptors 422
Carts 431
Isolation Accessories 433
Probes 437
Probe Accessories 456
Adaptors and Connectors 458
Mounting Accessories 460
Viewing Accessories 461











To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

Choosing a Tektronix Camera . . .

An Overview of Tektronix Camera Families

A camera can be a key part of your measurement system. It allows you to capture single events and document your results, and it helps you communicate your results with clarity and credibility. The following pages give information to help you select a camera well suited to your needs.

MOUNTING ADAPTORS

The table on page 424 indicates the camera adaptors required for most Tektronix Instruments and a few by other manufacturers. In some cases, adaptors are available from Hewlett-Packard or others to mount Tektronix cameras to their instruments.

POWER REQUIREMENTS

C-50 Series

The C-51 and C-53 electric shutters require +15 volts, normally supplied by a 7000 Series oscilloscope. An optional battery pack (016-0270-02) is available for situations where one of these cameras is used on a non-7000 Series instrument. These shutters can be actuated by a switch closure to ground. The C-59A has internal batteries or uses power from the 7000 Series mainframe.

C-5C

The C-5C uses four AA alkaline batteries.

C-28

It requires external +15 volts at 750 mA. The power connector is located on the underside of camera's front section.

GRATICULE LIGHTING

Most scopes have graticule illumination. For those that do not, an image of the graticule may be obtained by using the flash on the C-5C Camera or a storage scope's background (flood guns).

LENSES

Tektronix camera lenses differ mainly in light gathering ability, magnification, and field of view.

Speed

The f-number of a lens inversely signifies its aperture area and light gathering ability. For example: the aperture area of an f/1.4 lens is four times that of an f/2.8 lens of the same magnification and gathers four times the light. The relative light gathering ability of all lenses used in Tektronix cameras is referenced to the f/1.9, 0.85 magnification lens which is arbitrarily rated at 1.0. For recording a stored or stable recurrent CRT display, a lens as slow as the f/16 type used in the C-5C Camera is adequate. However, to record a fast, dim, single-sweep trace, you may need a lens as fast as the f/1.2 types used in the C-31B and C-51 Cameras.

MAXIMUM MAGNIFICATION TO RECORD ENTIRE SCREEN

Screen Size	5 x 6.3 cm	7.2 x 9 cm	8 x 10 cm	9.76 x 12.2 cm
Polaroid 3¼ x 4¼ in pack and roll film	1.0	1.0	0.85	0.67
4 x 5 in films	1.0	1.0	1.0	0.85 or less
6 x 7 cm format roll film (70 mm, 120, 220, etc.)	1.0	0.67	0.67	not recommended

Field of View

The description for each camera includes a statement of its field of view; this signifies how large a CRT display the camera can fully record. It is determined by the combined effects of the magnification and angular field of view of the lens, any field-limiting apertures in the camera adaptor, camera body, film holder, and the image area of the film. (See "Maximum Magnification" chart on this page.)

Magnification

Modern optical technology has made possible wide-aperture, wide-angle, flat-field lenses with short focal length for more compact cameras. To realize their inherent low distortion, high resolution, and uniform focus, these fixed focal length lenses must be used at their design center magnification.

Operating such lenses at a different magnification tends to compromise their important performance characteristics. For this reason, most Tektronix cameras are designed for use at one lens magnification. One exception is the C-30B Camera which has a magnification range of 0.7 to 1.5 (at some increase in distortion at the magnification extremes) to accommodate several portable oscilloscopes that have displays ranging in size from 3.8 x 6.3 cm to 8 x 10 cm.

The rated magnification of a lens signifies its image-to-object ratio. Note in the table below that only an image-to-object ratio of less than 7:1 can record the trace of a 6½ inch CRT.

For maximum resolution, the lens should produce the largest complete image possible within the image area of the film. The film most widely used for oscilloscope trace recording is Polaroid Type 107 pack film which has an image area of 73 x 95 mm. In most cases, the magnification is selected to provide the largest possible complete image of a particular display. An exception is in high writing speed applications where a 0.5 magnification lens is usually used to achieve higher writing speed by concentrating the trace light in a smaller area of the film.

SHUTTERS

Of the two available types of shutters, mechanical shutters are simple to operate and are economical. They are actuated by pressure on a release mechanism. Electrical shutters permit remote, automatic, or manual release and offer higher reliability. They may be actuated by an insulated switch closure.

VIEWING

Except for the C-30 Series, which have a dual swing-away hinge, all Tektronix cameras have a viewing port which provides a view of the CRT. All Tektronix cameras, except the C-5C, are hinge mounted and can be swung aside to allow a wide-angle view of the CRT. The light-weight C-5C can easily be removed to view the CRT or you can use the viewing door in the flash unit. C-5C's without a flash have a large lift-up viewing door in it's place. The C-28 and C-50 Series cameras have an off-axis viewing hood that accommodates eyeglasses for a comfortable binocular view of the CRT display while excluding ambient light.

FILM BACKS

Depending on your application you can choose from a wide variety of cameras and backs. All cameras, except the C-5C, have interchangeable backs. (See the specific camera for information on a particular back).

STANDARD AND OPTIONAL FILM BACKS AND HOLDERS AVAILABLE FROM TEK

	C-30 Series	C-50 Series	C-28	C-5C
Tek Modified Polaroid Backs				
3¼ x 4¼ in. pack	Std on "P" models	Std on "P" models		Noninterchangeable
Roll*1	Yes*1	Yes*1		NA
Graflok-Type*2 Interface	Std on*2 "G" Models	Std on*2 "G" Models	Std*2	
Polaroid 3¼ x 4¼ in. pack holder	Yes	Yes	Comes Std	
Polaroid 4 x 5 in. single sheet holder	Yes	Yes	Yes	
Polaroid 4 x 5 in. pack holder*3	*3	*3	*3	
120 mm roll	Yes	Yes	Yes	
70 mm roll	Yes	Yes	Yes	
4 x 5 in. cut film holder*4	*4	*4	*4	

**1 Polaroid is gradually reducing the number of its roll films. Scope camera roll backs are available in limited quantities from Tektronix.*

**2 Requires one of the film holders listed in order to be useable.*

**3 Will work but available only from Polaroid.*

**4 Will work but not available from Tek, see your local camera store.*

FILMS

Polaroid films are the most convenient to use. They offer the advantages of development in seconds to a finished dry print with wide spectral response, good resolution, and high sensitivity. ASA ratings do not necessarily give a true indication of how a film will respond in CRT recording due to the narrow spectral output range of most phosphors and different spectral sensitivity of various film types. See table on page 423 for listing of Polaroid films. Wet process, roll, or cut films can be used if the proper back is selected. (See the respective camera for optional backs.)

Manufacture of Polaroid 410 ROLL film, ASA 10,000, has been discontinued. Polaroid 612 PACK film, ASA 20,000, is now available for most high speed applications.

BLACK BODY COLOR STANDARD

All Tektronix cameras are supplied with a standard black body finish.

Technical assistance with Polaroid film and back questions or problems is available directly from The Polaroid Corporation. Call (800) 225-1618 toll free within U.S.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

PHOTOGRAPHIC WRITING SPEED

Photographic writing speed signifies the ability of a particular oscilloscope/camera system to provide a useful photographic record of a fast single-sweep trace. It is stated as an oscilloscope performance characteristic and is expressed in cm/μs or cm/ns. It is designed to answer the question, "What is the speed of the fastest single-sweep trace the system can record?" All statements of writing speed must specify the measurement conditions, including the CRT phosphor and film used, and the definition of a readable trace image.

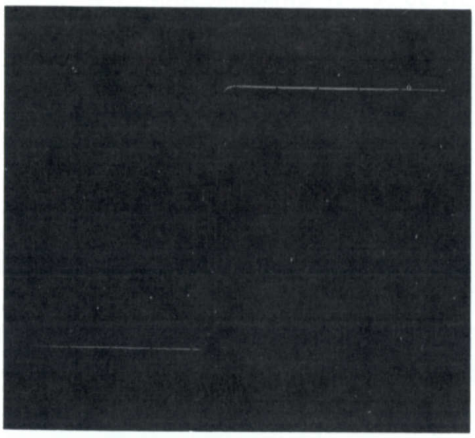
Increasing Writing Speed

Film fogging is a technique for increasing the maximum sensitivity of photographic film by giving it a short exposure to dim, diffuse light. The Tektronix Writing Speed Enhancer (WSEN) is designed to fill this need.

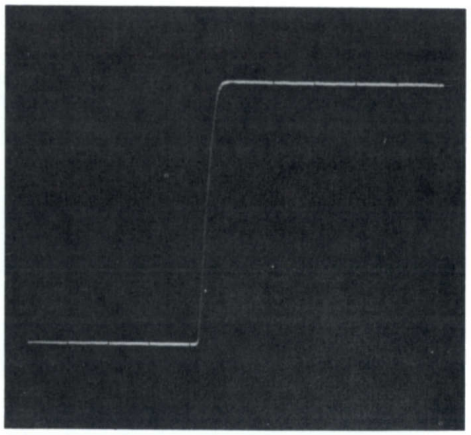
The Enhancer installs in minutes, and can be triggered in three ways; by a pushbutton on the control box; remotely, with a switch closure to ground (such as provided by the camera-shutter x-sync switch); or by the oscilloscope-sweep + gate.

Thus, the film can be fogged before, after, or while the sweep occurs. The techniques are respectively called prefogging, postfogging, and simultaneous fogging. Of these modes, simultaneous fogging provides the greatest gain in writing speed. Automatic, simultaneous fogging is easily achieved by triggering the Enhancer with the oscilloscope-sweep + gate.

For more information on photographing high speed signals request application note 42W-5335.



Polaroid Type 107, 3000 speed pack film was exposed to the single-trace display of a pulse waveform with a fast rising leading edge too dim to produce a developable image.



Film from the same pack was exposed to the same single-trace waveform and simultaneously to light from a Writing Speed Enhancer. The Enhancer light supplied the additional photons needed at the weak film development centers formed by the dim leading edge, to produce a visible image of the entire waveform.

WSEN (Writing Speed Enhancer) diffuser with control box.

POLAROID FILM		RELATIVE FILM WRITING SPEED	
ASA Equivalent Speed	Type	Unfogged	Using a WSEN Fogged
3,000	667, 107, 084, 47	1 (Reference)	3*2
20,000	612*1	>2	>3.5*2

*1 Polaroid 612 PACK film, ASA 20,000, is now available with faster writing rate than previous 410 ROLL film.
*2 Value depends on film, scope, CRT, camera and the operator.

The more commonly used films for each type of camera back are listed below. Shaded text indicates preferred films.

POLAROID FILMS

Film Type	ASA Equivalent Speed	Development Time (Seconds at 75°F)	Format	Resolution (Line Pairs/mm)	Characteristics	CRT Recording Uses: Repetitive	Stored	TV Type (Gray Scale)	Scintillation Type Medical	Graphics Alpha-Numeric	Single Sweep
PACK FILMS — Actual image size 7.3 cm x 9.5 cm (2 7/8 x 3 3/4 in)											
611*1	200	45	Positive Print	20	Low Contrast, wide gray scale			X			
612*2	20,000	30	Positive Print	20 to 25	High Contrast						X
665	75	30	Negative	160 to 180	Medium Contrast, wide gray scale	X	X	X			
			Positive Print	14 to 20							
107	3000	15	Positive Print	16 to 20	Medium Contrast	X	X				X
084*2	3000	15	Positive Print	16 to 22	Medium Contrast	X	X	X	X		
667*1,*2	3000	30	Positive Print	11 to 14	Medium Contrast	X	X	X	X		X
669	80	60	Positive Print	11 to 14	Balanced for color—electronic flash	X		X			
ROLL FILM — Actual image size 7.3 x 9.5 cm (2 7/8 x 3 3/4 in) (46L and 146L are 6.2 x 8.3 cm)											
47	3000	15	Positive Print	20 to 22	Medium Contrast	X	X				X
46L	800	130	Positive Trans	35 to 40	Medium Contrast	X	X	X			
146L	200*3 100	30	Positive Trans	40 to 50	High Contrast, Blue Sensitive	X				X	
SHEET FILMS — Actual image size 8.9 x 11.4 cm (4 x 5 in)											
55			Positive Print	22 to 25							
55 P/N	50	20	Negative	150 to 160	Medium Contrast, wide gray scale	X	X	X			
57	3000	15	Positive Print	16 to 20	Medium Contrast	X	X			X	X
552 (8 Pack)	400	20	Positive Print	20 to 25	Medium Contrast	X	X	X		X	

*1 No coating required.
*2 Preferred for oscilloscope photography.
*3 Daylight rating.

A limited quantity of ROLL film camera backs is available for customers who wish to use roll films listed above. Contact your Tektronix Representative for information.

SELECTION GUIDE FOR CAMERAS AND MOUNTING ADAPTORS

Where two or more cameras are recommended, compare features and specs to optimize for your application.

OSCILLOSCOPE OR DISPLAY DEVICE	RECOMMENDED CAMERAS			ADAPTOR PART NUMBERS*10		
	HIGH WRITING RATE	GENERAL PURPOSE	LOW COST	C-5C	C-51, C-53, C-59, C-27, C-28	C-30, C-31
5000 Series						
5100 Series Nonstore*1*2*3 includes; 5110, 5112, D10, D12, 577/D1, 5116		C-59A	C-5C	016-0357-01	016-0249-06	Not recommended
5100 Series Storage*1*2*4 includes; 5111, 5111A, 5113, 5115 D11, D13, D15, 577/D2		C-59A	C-5C	016-0357-01	016-0249-06	Not recommended
5400 Series Nonstore*1*2 includes; 5403/D40, 5440, 5444, D40		C-59A	C-5C	016-0357-01	016-0249-06	Not recommended
5400 Series Storage*2*4 includes; 5403/D41, 5441, D41	C-51	C-53	C-5C	016-0357-01	016-0249-06	016-0248-01
5223*1		C-59A	C-5C	016-0357-01	016-0249-06	Not recommended
7000 Series						
8 x 10 cm Display includes; 7104, 7503, 7504, 7514, 7603N 7613, 7623, 7633, 7704, 7834 7844, 7854, 7903R, 7904, 7904A, T922R*2	C-51 C-31 Opt 01	C-53 C-30 Opt 01	C-5C C-5C Opt 01	016-0357-01	016-0249-06	016-0248-01
Large Screen Display includes;*1 7403, 7603		C-59A	C-5C C-5C Opt 01	016-0357-01	016-0249-06	Not recommended
Portables*5						
Older with 0.8 cm Graticule includes; 422, 453, 454, 485, 491	C-31	C-30		No adaptor	No adaptor*5	016-0306-01
Newer with 1 cm Graticule includes;*7 2445, 2465, 455, 464, 465, 465B, 465M, 466, 468, R468, 475, 475A, 432, 434, 442	C-31 Opt 01	C-30 Opt 01	C-5C Opt 02 C-5C Opt 04	016-0359-01	No adaptor*5	016-0269-03
1 cm Nonilluminated Graticule; 2213, 2215, 2235, 2236			C-5C Opt 04	016-0359-01	No adaptor*5	016-0269-03
¼ inch Graticule includes; 305, 314, 326, 335, 336, 1501, 1502	C-30	C-30		No adaptor	No adaptor*5	016-0327-01
TM 500 includes; SC 502, SC 503, SC 504	C-30	C-30		No adaptor	No adaptor*5	016-0327-01
Nonilluminated Graticule; 2335, 2336, 2337*8			C-5C Opt 04*8	016-0359-01	No adaptor*5	No adaptor
Display Monitors						
8 x 10 cm*2*3 includes; 601, 602, 605, 606, 606B, 607		C-28	C-5C	016-0357-01	016-0249-06	016-0248-01
Large Screen 10 x 12 cm includes;*1 603, 604, 608, 620, 624, 634		C-28	C-5C	016-0357-01	016-0249-06	Not recommended
Older 5 Inch Round*2						
502, 503, 504, 515, 516, 519, 530 & 540 Series, 550 Series, 580 Series, 575	C-51	C-53	C-59A	No adaptor	016-0225-04	016-0243-00
Older 5 Inch Rectangular						
560 Series includes;*2 561, 564, 567, 568		C-53	C-59A	No adaptor	016-0224-01	016-0244-00
TV Products						
380, 381		C-30B Opt 01		No adaptor	No adaptor	016-0327-01
520, 520A, 521, 521A, 522A*1*2		C-59A		No adaptor	016-0295-01	No adaptor
1480C		C-53	C-59A*9	No adaptor	016-0342-00*9	No adaptor
528A*2, 1420, 1421, 1422, 1424*1*2		C-59A	C-5C	016-0357-01	016-0249-06	016-0248-01
529*1		C-53		No adaptor	016-0224-01	016-0244-00
1740, 1741, 1742		C-30 Opt 01	C-5C Opt 04 C-5C Opt 02	016-0359-01	No adaptor*5	016-0269-03
Spectrum Analyzers						
491*5	C-30/C-31	C-30		No adaptor	No adaptor*5	016-0306-01
492, 492P, 496, 496P*2		C-59A	C-5C	016-0357-01	016-0249-06	016-0248-01
Others*6						
576, 5030, 5031		Only C-59A		No adaptor	016-0288-01 (C-59A only)	No adaptor
OF150 TDR			C-5C	016-0357-01	Not recommended	Not recommended
1240*8			C-5C	016-0357-01	Not recommended	Not recommended
T900 includes; T912, T921, T922, T932, T932, T935 excluding T922R, see 7000 Series)*8			C-5C Opt 03	016-0358-01	No adaptor*5	No adaptor

*1 Only cameras with <0.7 magnification can record the entire screen area of a 10 x 12 cm display.
*2 These scopes do not have camera power. The C-51 and C-53 may be used only if powered with 016-0270-02 battery pack.
*3 These scopes do not have illuminated graticules w/o mod.
*4 Though these scopes do not have illuminated graticules the graticule may be photographed using storage flood guns.
*5 Due to physical configuration the C-50 Family cannot be mounted.
*6 Adaptors for HP and other scope manufacturers are available from those manufacturers.
*7 A corrector lens is required to increase cameras field of view so that the full 8 x 10 cm CRT display area can be recorded. The camera should be changed from standard to Option 01, to do this order 016-0301-01 for the standard C-30 or 016-0269-04 for the standard C-31. These adaptors include the adaptor and corrector lens.
*8 These scopes have no CRT bezel, therefore a camera cannot be mounted. A hand held C-5C can obtain a record.
*9 The C-59A may be used with 016-0224-01, however the image size is reduced.
*10 See next page for mounting adaptor pricing.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

OSCILLOSCOPE CAMERA COMPARISON CHART

Camera	C-51	C-53	C-59A	C-30B	C-31B	C-28	C-5C
Features	Adjustable film & shutter speed Built-in viewer Single sweep mode Remote control Interchangeable film backs Fastest writing speed	Adjustable film & shutter speed Built-in viewer Single sweep mode Remote control Interchangeable film backs General purpose camera for 7000 Series scopes	Adjustable film & shutter speed Built-in viewer General purpose camera for CRTs up to 6½ inch Low cost Interchangeable film backs Internal batteries	Continuously variable magnification Dual swing-away hinge for viewing the CRT Easy operation Interchangeable film backs	Maximum writing speed for portable scopes Dual swing-away hinge for viewing the CRT Easy operation Interchangeable film backs	For XY, XT, gray scale photos, precision accuracy for 600 Series monitors Variable magnification Power supply required OEM Applications Interchangeable film backs	Low cost Easy to use General purpose Graticule illuminator Viewing door Two magnification ratios OEM Applications
Lens speed	f/1.2 to f/11	f/1.9 to f/16	f/2.8 to f/16	f/1.9 to f/16	f/1.3 to f/16	f/2.8 to f/16	f/16 (fixed)
Magnification	0.5	0.85	0.67	Variable: 0.7 to 1.5	0.5	0.67 or 0.85	0.67 or 0.85
Relative light gathering ability	3.0	1.0	0.65	1.0	2.7	0.65 or 0.5	0.02
Field of view with Polaroid pack	8x10 cm		10.2 x 12.7 cm	8 x 10 cm w/Opt 01 7 x 9 cm std	8 x 10 w/Opt 01 7 x 9 cm std	10.2 x 12.7 cm or 8 x 10 cm	9.8 x 12.2 cm or 8 x 10 cm
Shutter	Electrical, 1/60 to 4 s (bulb, time, single sweep), remote shutter actuation, X-sync, scope "+ gate" input		Mechanical, 1/125 to 1 s (bulb and time) X-sync	Mechanical, 1/125 to 1 s (bulb and time) X-sync		Electrical, 1/50 to 2 s (bulb, time open shutter)	Electrical, 1/10 to 5 s (bulb, time)
Film backs	Polaroid pack standard with "P" models Graflok back standard with "G" models	Polaroid pack standard with "P" models Graflok back standard with "G" models	Polaroid pack standard with "P" models	Polaroid pack standard with "P" models	Polaroid pack standard with "P" models	Graflok-type interface standard Polaroid pack holder included	Polaroid pack Noninterchangeable
Options			Adaptor frame and corrector lens for 576 & 5030, (016-0288-01) reduces magnification to 0.5	01 Corrector lens has fixed magnification of 0.8; relative light gathering ability of 0.9; 8 x 10 cm field of view. Comes with mounting adaptor (016-0269-03) to accommodate 2400 and 400 Series scopes with 8 x 10 cm CRTs.		01 Focus lights 02 Graflok focus screen & hood 03 No Polaroid back 04 0.8 magnification 05 0.9 magnification 06 1.0 magnification 08 Mounting Adaptor	01 02 03 04 See page 426 for specific selections
Optional Accessories	Mounting adaptors, battery pack (for C-51, C-53), writing speed enhancer (one for each model), Polaroid pack film back, Polaroid roll film back, Graflok 4 x 5 inch back and film holders, X-sync connector, carrying case.			Mounting adaptors, writing speed enhancer, Polaroid pack film back, Polaroid roll film back, Graflok 4 x 5 inch back and film holders, carrying case, X-sync cable, porta lens (for C-30B only).		Viewing hood	Mounting hood adaptors, flash unit, viewing door

CAMERA MOUNTING ADAPTOR PART NUMBERS AND PRICES

016-0217-00	$80	016-0269-03	$85
016-0223-01	$60	016-0269-04*2	$90
016-0224-01	$60	016-0295-01	$70
016-0225-04	$60	016-0299-00	$80
016-0226-01	$80	016-0301-01*3	$85
016-0228-01	$110	016-0306-01*4	$75
016-0243-00	$75	016-0327-01	$170
016-0244-00	$75	016-0342-00	$230
016-0248-01	$80	016-0357-01*5	$20
016-0249-06*1	$85	016-0358-01*6	$20
016-0263-00	$75	016-0359-01*7	$20

*1 Included with C-50 Series cameras.
*2 Adaptor with lens included with C-31 B Option 01 cameras.
*3 Adaptor with lens included with C-30B Option 01 cameras.
*4 Included with C-30B, C-31B Cameras.
*5 Included with C-5C and C-5C Option 01 Cameras.
*6 Included with C-5C Option 03 Cameras.
*7 Included with C-5C Option 02 and Option 04 Cameras.

POLAROID REPLACEMENT ROLLER ASSEMBLIES FOR PACK FILM BACKS

If your roller assembly is solid grey or two-tone grey
Order 401-0304-00 ..... **$26.00**

If your roller assembly is red and black
Order 401-0303-00 ..... **$26.00**

Note: Because of mechanical differences, both roller assemblies are incompatible with each other's back.

ACCESSORIES FOR OLDER TEKTRONIX CAMERAS

Polaroid Pack Film Back For Older Cameras: C-12, C-19, C-13, C-27

These cameras are no longer produced by Tektronix. However due to customer need for a Pack Film Back these are now available. The Pack Film Back accepts the Polaroid pack film.
Order 122-0671-01 ..... **$270**

Mounting Adaptors

C-12 to 7000 Series and 5000 Series
Order 016-0299-00 ..... **$80**

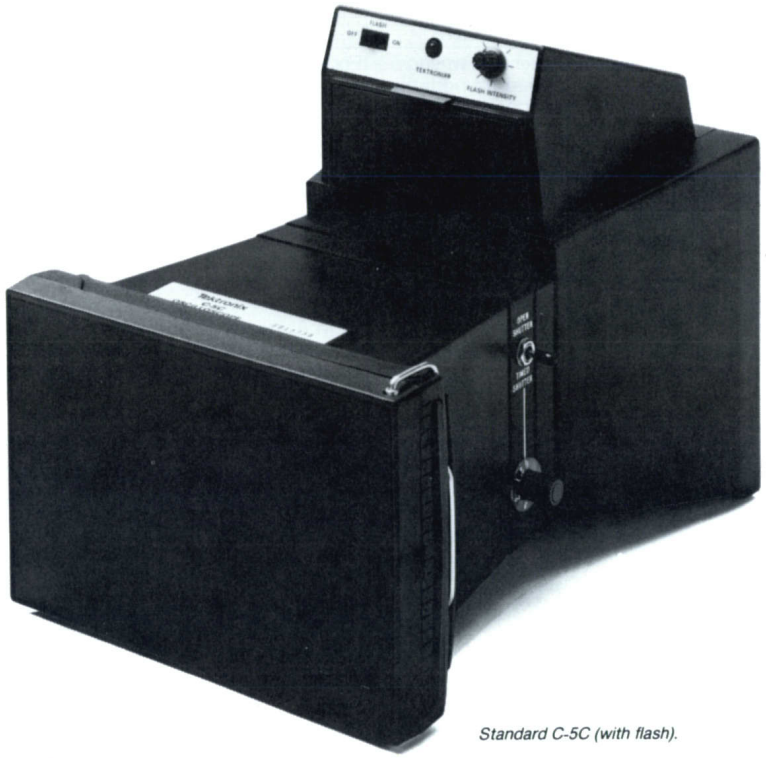
C-12 to 530, 540, 550 Series
Order 016-0226-01 ..... **$80**

C-12 to 560 Series rectangular CRTs
Order 016-0217-00 ..... **$80**

Writing Speed Enhancer for C-12, C-27

Provides controlled film fogging to increase writing speed by 3X for 3000 ASA film and >3.5X with 20,000 ASA film. Installs in minutes. Order 016-0280-02 ..... **$270**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.



Standard C-5C (with flash).

C-5C

Low Cost

Covers 8 cm x 10 cm or 9.8 cm x 12.2 cm CRT Displays

Easy to Use

Lightweight

Interchangeable Adaptor Hoods

Built-In Flash on Some Models

OEM Pricing Available

Maximum Performance at Minimum Cost

If your application does not require specialized photographic techniques, such as the capability to record single sweeps, this general purpose camera may fill your needs at exceptionally low cost. The C-5C is lightweight and modular, with a reliable electric shutter. The three-element f/16 lens offers both 0.67 and 0.85 magnifications, either of which you can easily change by reversing the lens/shutter module and the spacer module positions.

Flash

A variable-intensity xenon flash that evenly lights CRTs with nonilluminated graticules comes on the C-5C and Option 03. It can be easily retrofitted on C-5C's that do not have it.

Viewing Door

Flash models have a small built-in door. Nonflash models replace the flash unit with a large lift-up viewing door (016-0630-00).

Adaptor Hood

Comes standard with camera (chart on right), and they can be ordered separately. Easily changed by removing four screws inside hood.

OEM Quantities

Both the highly accurate C-28, page 430, and the low-cost C-5C Oscilloscope Cameras are available in OEM quantities.

Special pricing, terms and conditions are available to qualified OEMs. Contact your local Tektronix representative for complete information.

CHARACTERISTICS

Aperture — Fixed at f/16.

Lens — Three glass elements.

Magnification — 0.67 and 0.85.

Relative Light-Gathering Ability — 0.02.

Shutter — Electronic; 1/10 to 5 s; time, bulb.

Field of View — 9.8 cm x 12.2 cm (0.67 magnification) and 8.0 cm x 10.0 cm (0.85 magnification).

Power — The C-5C requires (4) AA alkaline batteries (not included).

C-5C Option 01 (with large viewing door).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	168	6.6
Height	140	5.5
Depth	257	10.1
Weights ≈	**kg**	**lb**
Net	1.4	3.0
Shipping	1.9	4.1

ADAPTOR HOOD FRONT LIP DIMENSIONS*1

	Adaptor Hood					
	016-0357-01		016-0358-01		016-0359-01	
Dimensions	cm	in	cm	in	cm	in
Height						
Inside	13.0	5.13	9.5	3.74	10.5	4.13
Outside	13.7	5.38	11.2	4.41	11.2	4.40
Width						
Inside	14.2	5.60	11.8	4.65	12.0	4.74
Outside	14.9	5.85	13.1	5.14	12.7	4.99

**1 All dimensions are approximate since each hood has additional plastic for notches and grooves for mounting.*

OPTIONAL ACCESSORIES

Large Viewing Door — Fits all three mounting adaptor hoods. Included with C-5C Options 01 and 02.
Order 016-0630-00 ..... **$7.00**

Graticule Flash Unit — Fits all three mounting adaptor hoods. Included with C-5C and C-5C Options 03 and 04.
Order 016-0642-00 ..... **$160**

Additional Mounting Adaptor Hoods — (Requires flash unit or large viewing door.)

For C-5C and C-5C Option 01. Order 016-0357-01 ..... **$20**

For C-5C Options 02 and 04. Order 016-0359-01 ..... **$20**

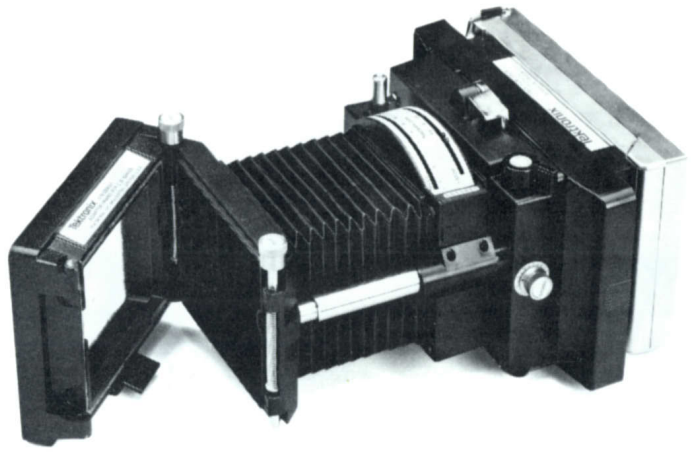
For C-5C Option 03. Order 016-0358-01 ..... **$20**

ORDERING INFORMATION

Order	For Use With: (see page 424 for other instruments)	Camera Comes Standard With: Adaptor Hood Part Number*1	Flash Unit*2	Large Viewing Door*3	Price
C-5C	577, 600 Series with unilluminated graticule 1420 Series, 5100 Series	016-0357-01	Yes	No	$530
C-5C Option 01	528, 600 Series without graticule, or with illuminated graticule, 5400 Series, 7000 Series, T922R TELEQUIPMENT D83	016-0357-01	No	Yes	−$20
C-5C Option 02	432, 434, 455, 464, 465B, 465M, 466, 468, 475, 475A 2400 Series	016-0359-01	No	Yes	−$20
C-5C Option 03	T900 Series except T922R	016-0358-01	Yes	No	NC
C-5C Option 04	2200 Series with unilluminated graticule	016-0359-01	Yes	No	NC

**1 Additional hoods available. Check if a flash or large viewing door is required.*
**2 Small viewing door built into flash unit.*
**3 016-0630-00 (large viewing door).*

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.



C-31BP shown.

C-30 Series

Standard Models Cover 0.8 cm/div CRTs

Adaptable to Many Instrument Types

Option 01 Optimized for 8 cm x 10 cm CRTs

Continuously Variable Magnification (C-30B)

Interchangeable Backs

Swings Away for CRT Viewing

The standard C-30B and C-31B models are primarily designed for use on the older 400 Series portables that have 0.8 cm/div CRT. (Mounting adaptor, 016-0306-01, is included.)

The Option 01 models are the same cameras except that a slip-on corrector lens is used for coverage of 8 cm x 10 cm displays, and a different mounting adaptor (016-0269-03 for 2400 Series, 465, etc.) is included.

The C-30B/C-31B Series of cameras can be used on some 7000 and 5000 Series lab scopes, 300 Series Sony/Tek portables, as well as 600 Series monitors. See Camera Selection Guide on page 424 for compatibility information.

Dual swing-away hinges allow the camera to be swung out of the way, either to the left or right, for direct viewing of the CRT. The cameras are focused, using a split-image focus plate placed inside the Polaroid back. Graflok back cameras use the back's (Graflok) built-in viewing glass.

C-30B

The C-30B is a versatile, general purpose camera for scopes that have 0.8 cm/div CRTs. The C-30B offers a highly reliable mechanical shutter and an f/1.9 lens. It is the only Tektronix oscilloscope camera that features continuously variable magnification (from 0.7 to 1.5) giving you greater photographing flexibility. This camera was designed for the 453, 454, 485 and 491.

C-30B Option 01

The C-30B Option 01 offers an expanded field of view. The f/1.9, 0.8 magnification lens covers an 8 cm x 10 cm CRT screen without vignetting. The relative light-gathering ability is 0.9. This camera is recommended for the 2400 Series, 455, 464, 465, 465B, 466, 468, 475, and 475A oscilloscopes.

C-30B CHARACTERISTICS

Specifications are the same for the C-30B and C-30B Option 01 unless otherwise noted.

Aperture — Variable from f/1.9 to f/16.

Magnifications — Variable from 0.7 to 1.5, (0.8 magnification on Option 01 with C-30B set to 1.0 magnification).

Relative Light-Gathering Ability — 1.0 (0.9 on Option 01).

Shutter — Mechanical, 1/125 to 1 s; bulb and time.

Synchronization — X-sync contact closure.

Field of View — 7.0 cm x 9.0 cm (8.0 cm x 10.0 cm on Option 01).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	191	7.5
Height	130	5.1
Depth	254	10.4
Weights ≈	**kg**	**lb**
Net	2.2	4.8
Shipping	4.1	9.0

C-31B

This camera's f/1.3, 0.5 magnification lens offers the fastest writing speed for 2400 and 400 Series oscilloscopes. The 0.5 magnification means that the image size on the print will be approximately one half of the C-30B's. The C-31B is for 0.8 cm/div CRTs (453, 485, 491, 454).

C-31B Option 01

The C-31B Option 01 also offers an expanded field of view. This f/1.2, 0.5 magnification lens has a relative light-gathering ability of 2.9 covering CRT screens up to 8 cm x 10 cm. It is recommended for the 2400 Series, 455, 464, 465, 465B, 466, 468, 475, and 475A oscilloscopes.

C-31B CHARACTERISTICS

Specifications are the same for the C-31B and C-31B Option 01 unless otherwise noted.

Aperture — Variable from f/1.3 to f/16.

Lens Speed — f/1.3

Magnification — 0.5 (0.43 on Option 01).

Relative Light-Gathering Ability — 2.7 (2.9 on Option 01).

Shutter — Mechanical; 1/125 to 1 s; bulb and time.

Synchronization — X-sync contact closure.

Field of View — 7 cm x 9 cm (8 cm x 10 cm on Option 01).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	231	9.1
Height	140	5.5
Depth	269	10.6
Weights ≈	**kg**	**lb**
Net	3.1	6.8
Shipping	5.4	11.0

INCLUDED ACCESSORIES (C-30B, C-31B)

STANDARD

Polaroid pack film back (122-0752-02); split-image focus plate (387-0893-02); mounting adaptor (016-0306-01); instruction manual.

OPTION 01

Polaroid pack film back (122-0752-02); C-30B corrector lens (352-0341-01) or C-31B corrector lens (122-0980-00); mounting adaptor (016-0269-03); split-image focus plate (387-0893-02); instruction manual.

ORDERING INFORMATION

C-30BP Camera **$1,375**

Option 01 — Expanded field of view ..... **+$42**

C-31BP Camera **$1,585**

Option 01 — Expanded field of view ..... **+$42**

All models include Polaroid pack film back.

CONVERTING OPTION 01 MODEL TO STANDARD MODEL

The Option 01 versions of the C-30B and C-31B Cameras can be converted to standard models by simply slipping off the corrector lens, removing the mounting adaptor, and adding an 016-0306-01 mounting adaptor. Refer to pages 424-425 for compatibility and price.

CONVERTING STANDARD MODEL TO OPTION 01 MODEL

A standard-model C-30B or C-31B can be converted to an Option 01 model by means of a conversion kit which contains a mounting adaptor (016-0269-03) plus the appropriate corrector lens (see Option 01's "Included Accessories").

Std C-30B to Option 01. Order 016-0301-01 ..... **$85**

Std C-31B to Option 01. Order 016-0269-04 ..... **$90**

Refer to pages 424-425 for prices and compatibility.

C-30 SERIES OPTIONAL ACCESSORIES

Mounting Adaptors — See page 424.

Writing Speed Enhancer — Increases effective film speed about 3X for 3000 speed film. Now supports 20,000 ASA (612) film. Installs in minutes.
Order 016-0284-02 ..... **$270**

Polaroid Pack Film Back — Accepts Polaroid pack film. Included with "P" models. (Focus plate included.)
Order 122-0752-02 ..... **$185**

Split-Image Focus Plate — Included with "P" models.
Order 387-0893-02 ..... **$4.00**

Graflok Type 4 x 5 in Back — Accepts Polaroid Land 4 x 5 in film holders, standard cut film holders, filmpack adaptors, roll film holders (except heavy motorized roll film holders).
Order 016-0487-00 ..... **$260**
Refer to page 429 for film holders which are required for operation.

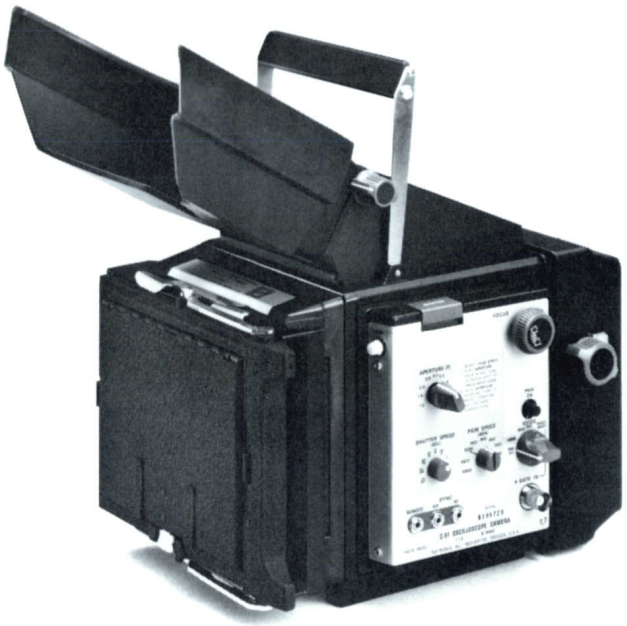
Carrying Case — Molded high-impact plastic case with polyurethane foam liners to protect your camera in transit. 18.5 in x 14.5 in x 8 in. Order 016-0587-00 ..... **$120**

X-Sync Cable — Order 012-0364-01 ..... **$25**

Portra Lens — A slip-on auxiliary lens which extends the focus distance of the camera so it can be used for off-scope photography of scenes such as test set-ups. At a distance of 21 inches the camera covers 19 inches x 21 inches. Usable with either the C-30B or C-30B Option 01. Order 016-0246-02 ..... **$35**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

C-51G



C-53P

C-50 Series

Electronic-Actuated Shutter (C-51, C-53)

Photometer Exposure Aid

Range-Finder Focusing

Interchangeable Film Backs

The Top of the Line

The three C-50 Series cameras are designed for use with all Tektronix 7000 Series oscilloscopes, and can be adapted to fit most 5000 Series oscilloscopes as well as other Tek instruments. Full selection of film backs, and adjustable film and shutter speeds give you the flexibility you need to best record your measurements. The photometer exposure aid, similar to light meters used in conventional photography, provides an easy way to approximate the correct exposure for repetitive or stored traces. X-sync connectors allow the camera shutter to trigger the event. And each camera's built-in viewing tunnel lets you see what's on the display when the camera is in place.

The camera shutter (C-51 and C-53) is electrically actuated through a shutter actuator circuit by a pushbutton, or remotely through a remote input connector. Both the pushbutton and remote input connector are located on the control panel.

When the C-50 Series camera is used with the Tektronix 7000 Series oscilloscopes, a three-pin connector in the oscilloscope bezel applies power to the camera and receives from the camera a pulse for resetting the oscilloscope sweep when the oscilloscope and camera are both in single-sweep modes. Also, when the oscilloscope and camera (C-51 and C-53 only) are in the single-sweep mode, the "+ gate" output from the oscilloscope can be applied to the "+ gate" input connector on the camera to close the shutter five seconds after the end of the oscilloscope sweep.

C-51

Fastest Writing Speed

Automatic Single Sweep Mode

This camera offers the fastest writing speed of any Tektronix oscilloscope camera. The f/1.2 lens shoots images at 0.5 magnification, clearly capturing fast transients or single sweeps, although at some expense to image size. The C-51's electric shutter can operate at speeds ranging from 1/60 to 4 seconds, and offers bulb, time, and single sweep modes by manual or remote control.

CHARACTERISTICS

Aperture — Variable from f/1.2 to f/16.

Magnification — 0.5.

Relative Light-Gathering Ability — 3.0.

Shutter — Electric; 1/60 to 4 s, bulb, time, and single sweep modes, manual or remote control. Scope's "+ gate" is used for shutter actuation.

Power Requirement — +15 V from 7000 Series oscilloscopes, or an optional battery pack for non-7000 Series instruments (see next page).

Synchonrization — X-sync switch closure.

Field of View — 8 cm x 10 cm (with pack film).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	248	9.8
Height	292	11.5
Depth	273	10.8
Weights ≈	**kg**	**lb**
Net	4.3	9.5
Shipping	6.8	15.0

C-53

General Purpose Medium Speed

Fastest Camera Without Image Reduction

8 cm x 10 cm Field of View

Automatic Single Sweep Mode

The C-53, like the C-51, provides an 8 x 10 cm field of view when used with Polaroid pack film. Its f/1.9 lens and 0.85 magnification, however, offer somewhat slower writing speed. This camera's electric shutter also offers speeds ranging from 1/60 to 4 seconds, and can be operated manually or remotely in bulb, time, or single sweep mode.

CHARACTERISTICS

Aperture — Variable from f/1.9 to f/16.

Magnification — 0.85.

Relative Light-Gathering Ability — 1.0.

Shutter — Electric; 1/60 to 4 s, bulb, time, and single sweep modes, manual or remote control. Scope's "+ gate" is used for shutter actuation.

Power Requirement — +15 V from 7000 Series oscilloscopes, or an optional battery pack for non-7000 Series instruments (see next page).

Synchronization — X-sync switch closure.

Field of View — 8 cm x 10 cm (with pack film).

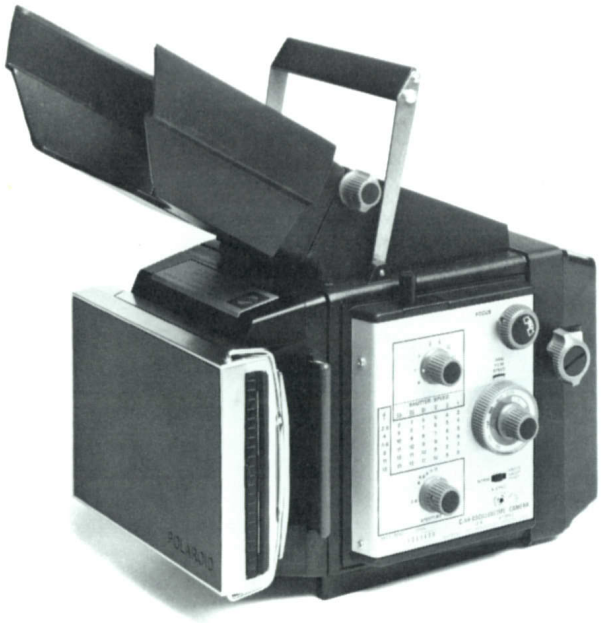
PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	191	7.5
Height	292	11.5
Depth	273	10.8
Weights ≈	**kg**	**lb**
Net	2.4	7.5
Shipping	5.4	12.0

For Ordering Information see next page.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

C-59AP



C-59A

Low-Cost

Photometer Exposure Aid

Range-Finder Focusing

Internal Battery or External Power

For Larger CRT'S

This camera is designed for CRTs up to 6½ inches, and has a 10.2 cm x 12.7 cm field of view with Polaroid pack film. With the use of an adaptor frame/corrector lens optional accessory, the camera's field of view can be expanded to fully cover the 6½ inch CRT and adjacent scale readout characters of the Tektronix 576 Curve Tracer and the 5030 Series oscilloscopes. It is the only C-50 Series camera for the 7603. Many of the features of the high-priced C-50 Series cameras are standard on the C-59A: photometer exposure aid, range-finder focusing, bulb and time operating modes, X-sync contacts, and film back interchangeability.

CHARACTERISTICS

Aperture — Variable from f/2.8 to 1/16.

Magnification — 0.67.

Relative Light-Gathering Ability — 0.65.

Shutter — Mechanical; 1/125 to 1 s; bulb and time.

Synchronization — X-sync switch closure.

Field of View — 10.2 cm x 12.7 cm (wider with optional 016-0288-01 adaptor frame/corrector lens).

Power Requirement — Receives power (+15 V) from a 7000 Series oscillsocope, or from an internal battery pack, 8 AA size alkalines, (12 V) if used on a non-7000 Series scope.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	193	7.7
Height	292	11.5
Depth	273	10.8
Weights ≈	**kg**	**lb**
Net	3.2	7.0
Shipping	5.0	11.0

INCLUDED ACCESSORIES (C-50 SERIES)

Mounting adaptor for all 7000, 5000, and small 600 Series (016-0249-06); camera visor (337-0411-02); "P" models include focus plate (387-0893-02); instruction manual. Polaroid pack film back (122-0926-02). "G" models include Graflok film back (122-0931-01) with integral focusing screen.

C-59 does not include 8 AA size alkaline batteries.

ORDERING INFORMATION

"P" Models accept only Polaroid pack film.

"G" Models have A Graflok type back that requires A film holder (see next column)

C-51 CAMERA

C-51G **$2,185**

C-51P **$2,185**

C-53 CAMERA

C-53P **$1,800**

C-59A CAMERA

C-59AG **$1,275**

C-59AP **$1,275**

C-59A Adaptor Frame with Corrector Lens — Expands the field of view to fully cover the 6½ inch CRT and adjacent scale readout characters of the 576 Curve Tracer and 5030 Series oscilloscopes. The slip-on corrector lens reduces the effective magnification of the C-59 from 0.67 to 0.5 so it can record the entire display on Polaroid 3¼ x 4¼ inch film (for the C-59A camera only). Adapts camera to 576, 5030, and 5031.
Order 016-0288-01 ..... $125

C-50 SERIES OPTIONAL CAMERA ACCESSORIES

Mounting Adaptors — See table on page 424.

Battery Pack — Provides auxiliary +15 V power source for using the C-51, C-53 Cameras with oscilloscopes without camera power. A three-position mode switch on the battery pack also allows the camera to be powered from a 7000 Series oscilloscope or an external +15 V source. Net weight, including batteries, is 1.2 lb. Requires 12 AA size alkaline batteries (not included). Order 016-0270-02 ..... **$250**

Writing Speed Enhancer — Provides controlled film fogging to increase writing speed by 3X for 3000 ASA film and ⩾3.5X with 20,000 ASA film. Installs in minutes.
For C-51 Order 016-0279-02 ..... **$250**
For C-53 Order 016-0300-02 ..... **$250**
For C-59A Order 016-0290-02 ..... **$250**

X-Sync Connector Plug — Not shown.
Order 134-0079-00 ..... **$1.30**

Carrying Case — Hold a complete C-50 Series camera with extra film backs and accesssories.
Order 016-0177-00 ..... **$285**

Polaroid Pack Film Back — Included with "P" models.
Order 122-0926-02 ..... **$175**

Focus Plate — Included with "P" models.
Order 387-0893-02 ..... **$4.00**

Graflok Type Film Back — Included with "G" models, accepts Polaroid 4 x 5 inch film holder, standard cut-film holders, film-pack adaptors, roll-film holders*1 (except heavy motorized models). Includes integral focusing screen.
Order 122-0931-01 ..... **$240**

OPTIONAL FILM HOLDERS FOR GRAFLOK TYPE BACKS ("G" MODELS ONLY)

Cameras with Graflok type backs must have a film holder in order to be functional.

Here are several holders*1 that allow the use of roll film, or 4 x 5 inch Polaroid films. Order these holders from Tek, the manufacturer, or from your local camera store.

Polaroid Land #545 4 x 5 Film Holder — For Polaroid 4 x 5 inch Single Exposure Film Packets.
Order 016-0201-01 ..... **$285**

RH/10 120 Roll-Film Holder — 10 exposures 2¼ x 2¾ inch for 4 x 5 inch Graflok Backs.
Order 122-0736-01 ..... **$360**

RH/50 70 mm Holder — 50 exposure, 2¼ x 2¼ inch for 4 x 5 inch Graflok Backs only.
Order 122-0967-00 ..... **$275**

Roll film holders are also manufactured by several other companies.

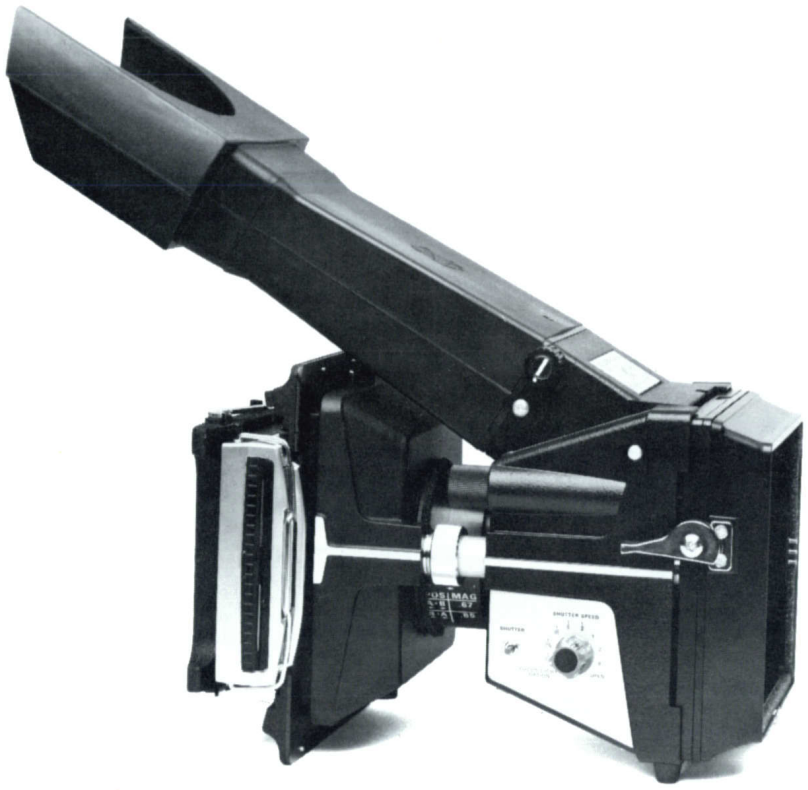
**1 Other film holders and adaptors (4 x 5 cm cut film, pack film, or roll film) are available at local camera store.*

The following film holders are available only through Polaroid (1-800-225-1618 in the U.S.).

Polaroid #550 Film Holder — For Polaroid 4 x 5 pack films. Holder fits most 4 x 5 cameras and instruments equipped with Graflok backs, which accept conventional 4 x 5 film holders.

Polaroid #405 Film Holder — For Polaroid 3¼ x 4¼ in pack films. Holder fits most 4 x 5 cameras or instruments equipped with Graflok backs, which accept conventional 4 x 5 film holders.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.



C-28 with Option 02 and Option 08.

C-28

Used with UL Approved Medical and Dental Equipment

Rangefinder Focusing (Option 01)

Rigid Body Design Eliminates Distortion Errors

OEM Pricing Available

When Measurement Accuracy is Critical

The C-28 Camera is a high quality recording device for systems displaying XY, XT, or gray scale images. It is recommended for use with 600 Series display monitors, and offers broad interface capability with many oscilloscopes. And its UL Component Recognition allows the C-28 to interface with UL approved medical and dental equipment.

The accurate reproduction quality of C-28 photographs results from a special rigid body design that eliminates focus errors and trapezoidal distortion, even with heavy motorized roll film backs.

The C-28 f/2.8 lens has interchangeable 0.67 and 0.85 magnification which you can easily change to fully record from 102 mm x 127 mm or 80 mm x 100 mm CRTs. Lens mounts with fixed magnifications of 0.8, 0.9, and 1.0 are available as options. A reliable electric shutter with a wide choice of speeds from 1/50 to 2 seconds can be operated manually or remotely in bulb or time mode. Optional rangefinder focus lights allow easy, accurate focusing without necessitating film removal.

This camera's versatility extends to its standard combination Graflok/Polaroid film back. The Polaroid pack film holder takes 3 1/4 inch x 4 1/4 inch photos horizontally or vertically and is easily removed, leaving a Graflok-type interface for Graflok-compatible accessories.

OEM Quantities

Both the highly accurate C-28 and the low cost C-5C, page 426, Oscilloscope Cameras are available in OEM quantities with special pricing, terms, and conditions.

CHARACTERISTICS

Aperture — Variable from f/2.8 to f/16.
Lens Speed — f/2.8
Magnification — 0.67 and 0.85 (0.8, 0.9, and 1.0 optional).
Shutter — Electric: 1/50 to 2 s, bulb, and time.
Synchronization — Switch closure coincident with shutter opening. 28 V 750 mA rating.
Field of View — 80 mm x 100 mm (0.85 magnification) and 102 mm x 127 mm (0.67 magnification).

POWER REQUIREMENTS

Voltage Input — +15 V dc ±0.5 V.
Current Drain — ≈260 mA with focus lights on. ≈250 mA with shutter open. ≈25 mA idle.
Power Consumption — ≤12 W.
Note: Power supplied by user — Camera supplied with power cord and connector.

REMOTE SHUTTER INPUT

Maximum Input — −1 V to +10 V (dc or peak transient).
Input Requirement for Shutter Actuation — TTL: Transition from ≥2.5 V dc to ≤0.9 V dc in 10 μs or less, and remaining low for at least 50 μs. Bulb requires a continuous low while the shutter is open. Switch Closure: Transition from ≥7.5 kΩ to ≤1 kΩ in 10 μs or less, and remaining low for at least 50 μs. Minimum time interval between shutter operations is not <500 ms.

ENVIRONMENTAL CHARACTERISTICS

Temperature Range to Assure Specified Performance — Operating: 0°C to +50°C. Nonoperating: +32°F to +122°F.

Altitude — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	185	7.3
Height	205	8.1
Depth	246	9.7
Weights ≈	**kg**	**lb**
Net	3.8	8.5
Shipping	5.9	13.0

INCLUDED ACCESSORIES

Six-pin connector and 18-inch power and control cable assembly (131-1794-00); viewing tunnel and hood (122-0719-01); Polaroid pack film holder (352-0505-01); focus plate for Polaroid holder (387-0893-02); instruction manual.

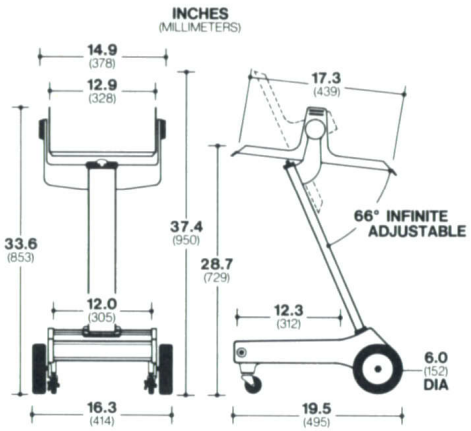
ORDERING INFORMATION

C-28 Camera with Graflok-type Interface with Polaroid Pack Film Holder **$1,580**

Option 01 — With Focus Lights ..... **+$55**
Option 02 — With Graflok focus screen and hood. (122-0510-00 and 122-0944-00) ..... **+$110**
Option 03 — Without Polaroid pack film holder (deletes 352-0505-01) ..... **−$50**
Option 04 — 0.8 magnification only ..... **+$45**
Option 05 — 0.9 magnification only ..... **+$45**
Option 06 — 1.0 magnification only ..... **+$45**
Option 08 — With Mounting Adaptor for 600, 5000, and 7000 Series (016-0249-06) ..... **+$65**

Special pricing, terms and conditions are available to qualified OEM's. Contact your local Tektronix representative for complete information.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.



MODEL 200C/200D

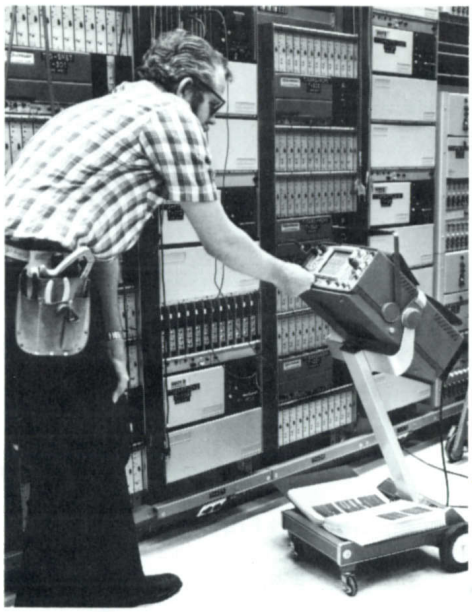
Recommended For:
All 400, 2200 and 2400 Series portable scopes.

MODEL 200C includes brakes on front casters, safety belt to secure instrument on top tray. Net weight is 7.3 kg, (16 lb). Shipping weight is 12.2 kg, (27 lb).

ORDERING INFORMATION

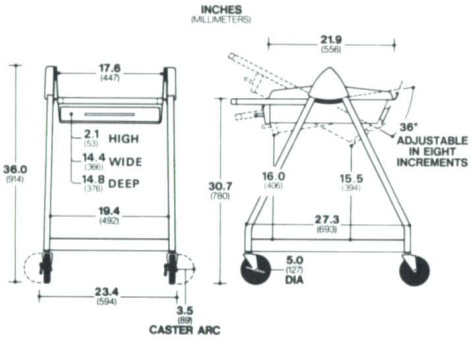
Model 200C Blue Vinyl Finish **$320**

Model 200D Brown Vinyl Finish **$320**



Model 200C

Model 205



MODEL 205/205D

Recommended For:
All rackmount width instruments. Note width dimension of top tray in diagram above. Rackmounting ears overhang sides of tray. Maximum top surface weight 80 lb.

MODEL 205 includes brakes on front casters, storage drawer, power distribution module (three outlets, 15 ft cord). Net weight is 19.5 kg (43 lb). Shipping weight is 25.8 kg (57 lb).

ORDERING INFORMATION

Model 205 Blue Vinyl Finish **$475**

Model 205D Brown Vinyl Finish **$475**

OPTIONAL SAFETY BELT recommended to secure instruments on top tray. Net weight is 0.23 kg (0.5 lb). Shipping weight is 0.45 kg (1 lb). Used with both 205 and 205D.
Order 346-0070-01 ..... **$48**

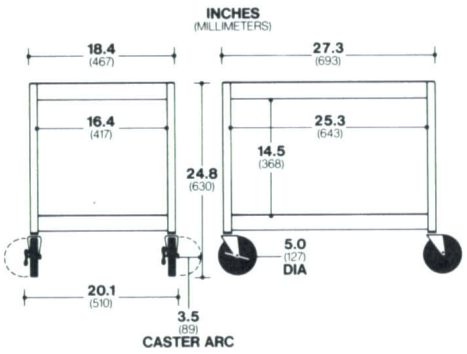
CARTS

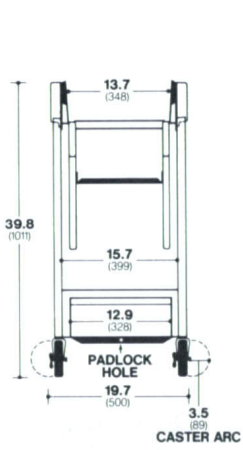
QUICK REFERENCE

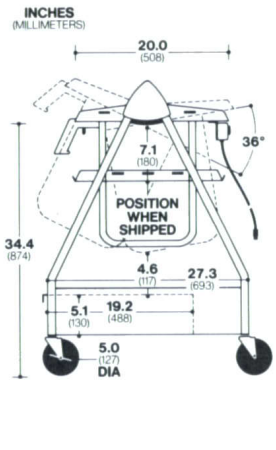
Product	Cart Model
DAS 9100 Series	Model 205D
OF150	*1
TM 5003	Model 3 or Model 3D
TM 5006	Model 205 or Model 205D
TM 503	Model 3 or Model 3D
TM 504	Model 3 or Model 3D
TM 506	Model 205 or Model 205D
1240 Series	Model 3 or Model 3D
1420 Series	*1
2200 Series	Model 200C or Model 200D
2400 Series	Model 200C or Model 200D
400 Series Portables	Model 200C or Model 200D
468, 492, 492P, 496, 496P	Model 3 or Model 3D
4000 Desktop Series	Model 206 or Model 206D
4600 Plotters and Hard Copy System	Model 206 or Model 206D
4900 File Managers	Model 206 or Model 206D
5000 Series	Model 3 or Model 3D
520A, 521A, 522A	Model 205 or Model 205D
528	*1
530, 540, 550 Series	Model 3 or Model 3D
560 Series	Model 3 or Model 3D
576	Model 206 or Model 206D
577	Model 206 or Model 206D
600 Series Monitors	*1
650 Series	Model 205 or Model 205D
670 Series	Model 205 or Model 205D
7000 Series	Model 3 or Model 3D

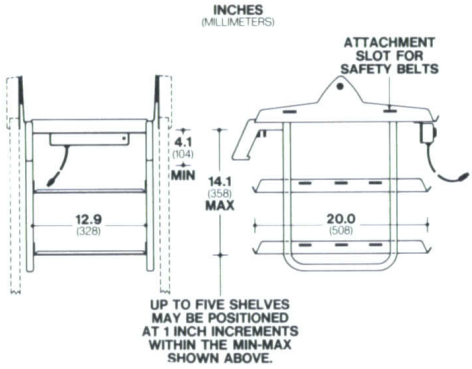
**1 These products are applicable to several carts — see dimensions and features for your specific needs.*

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.









MODEL 206/206D

Recommended For:

Computer terminals, calculators, and peripherals. General instruments, laboratory and office equipment. Maximum top surface weight is 100 lb.

MODEL 206 includes brakes on caster at one end of cart. Plastic laminate on top tray and base. Net weight is 13.6 kg, (30 lb). Shipping weight is 17.2 kg (38 lb).

ORDERING INFORMATION

Model 206 Light Gray Vinyl Finish **$230**

Model 206D Brown Vinyl Finish **$230**

TEK LAB CART MODEL 3/3D

Recommended For:

Maximum recommended weight 65 lbs on tray top. 5100, 5400, and 7000 Series three and four plug-in oscilloscopes, TM 503, and TM 504 mounted on top tray.

TM 503, TM 504 mounted on shelves.

MODEL 3 includes drawer in base with provision for padlock, brakes on all casters, power distribution module (four outlets and 15 ft cord), removable scope lock-down bar on top tray, one shelf, one safety belt, UL listed. Net weight is 25.8 kg, (57 lb). Shipping weight is 34 kg, (75 lb).

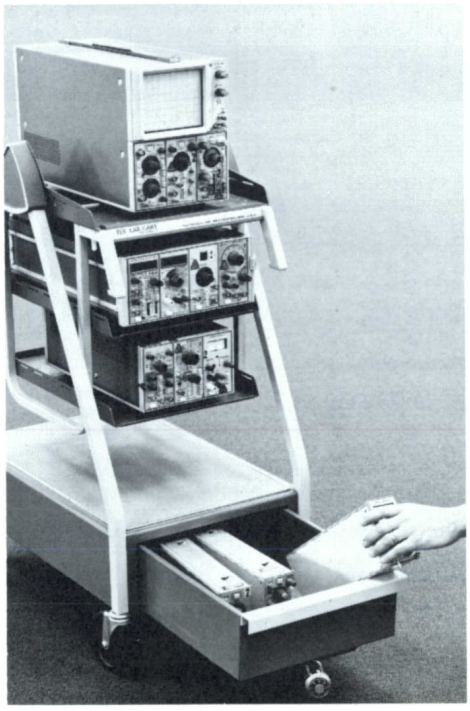
ORDERING INFORMATION

Model 3 Blue Vinyl Finish **$560**

Model 3D Brown Vinyl Finish **$560**

INTERNATIONAL VERSION deletes power module for shipment outside U.S.A.

Order Option 01 ..... **NC**



The Model 3 is shown with the 436-0132-01 Optional Shelf.

OPTIONAL ACCESSORIES

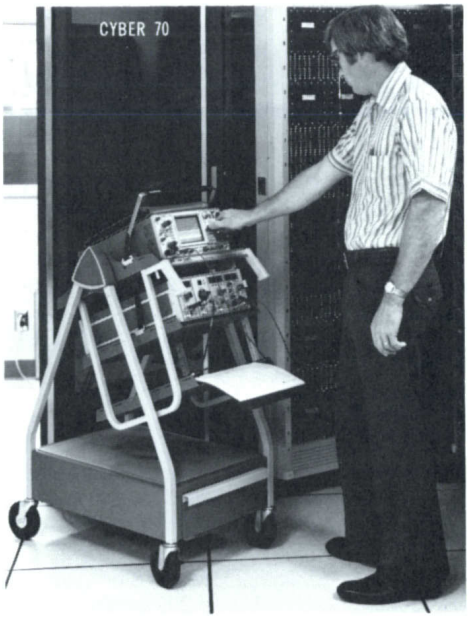
Extra shelf with four mounting screws. Net weight is 0.4 kg (0.9 lb). Shipping weight is 1.4 kg (3 lb).

Model 3 — Order 436-0132-01 ..... **$37**

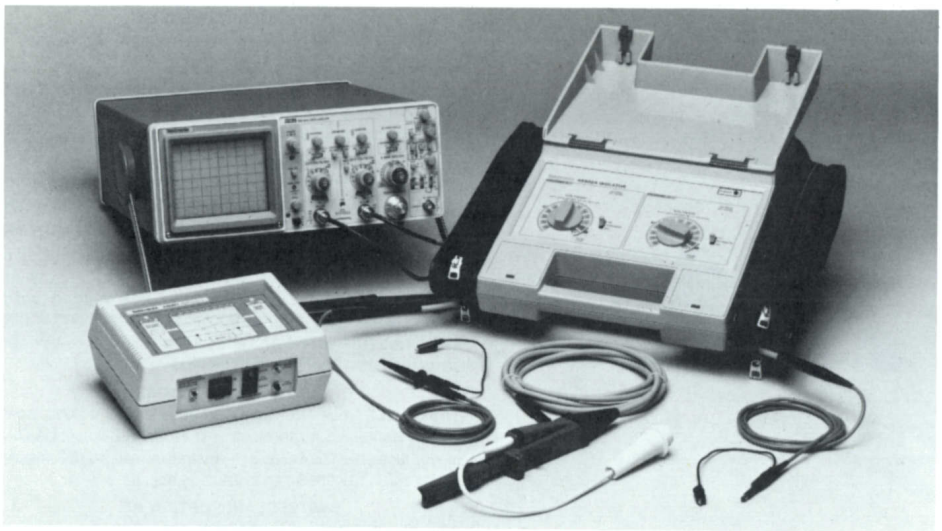
Model 3D — Order 436-0132-02 ..... **$55**

SAFETY BELT to secure instruments on top tray, shelves, or base 42 inch. (Not needed for 5000 or 7000 Series scopes on top tray.) Net weight is 0.23 kg (0.5 lb). Shipping weight is 0.45 kg (1 lb). Used with both Model 3 and Model 3D. Order 346-0136-01 ..... **$24**

For 7000 or 5000 Plug-in Storage on shelves contact Modified Products.



To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.



ISOLATION ACCESSORIES FOR FLOATING MEASUREMENTS

In the world of oscilloscope use, the problem of floating measurements is a pressing need that often causes users to employ questionable and often unsafe practices to allow the oscilloscope chassis to float at some potential other than ground. Such practices are parts of a larger problem concerning equipment grounding. In a recent study of computer data, OSHA found that faulty grounding of electrical equipment connected by cord and plug was one of the most common violations of accepted safety rules.

Recognition of the measurement need and a firm commitment to test and measurement product safety have resulted in two new isolator products from Tektronix. These products will allow you to make those necessary floating measurements with minimum risk of operator injury or test equipment damage. Both meet worldwide safety standards; including UL 1244, VDE, CSA Electronics Bulletin 556B, IEC 348 and BS 4743.

Ground Loops

The potential difference between two green wire grounds on separate mains circuits may be as great as 5 volts RMS at 60 Hz. An oscilloscope plugged into one main circuit would thus measure a signal on a system plugged into another mains circuit equal to the sum of the signal plus the difference between the green wire grounds. A logic signal typically swings 1.8 volts. With this logic signal imposed on that 5 volts 60 Hz signal, making measurements becomes difficult if not impossible. Traditional oscilloscope designs cannot effectively cope with these problems alone. All too often, the problems almost force users into employing dangerous measurement techniques. But why is this?

Most oscilloscopes have a "signal common" terminal that is connected to the protective grounding system. This is because all signals applied to or from an oscilloscope must have a common connection point. This is ordinarily the oscilloscope chassis, which is usually at zero volt. To prevent one input from becoming live when another is connected to a signal, the common connection point is connected to the protective grounding system of the oscilloscope.

While this arrangement usually works well and is safe for the user, it also provides that, with few exceptions, all measurements must be made with respect to ground. This constrains the oscilloscope (at least in a single measurement) from being used to measure potential differences between points where neither is at ground potential. Also, measurements can be exceedingly difficult to perform because probes and connectors can introduce unwanted circulating currents, ground loops, into the circuit under test. Such circulating currents impose noise on the signals to be examined and can interfere with system operation through the connection of the probe ground.

"Floating the scope" is the usual technique that is used in such measurements. It is the technique of defeating the protective grounding system—disconnecting the "signal common" from ground—and allowing accessible oscilloscope parts, such as the chassis, enclosure, connectors, and controls to assume the potential of the point at which the ground lead is connected. This is dangerous for two reasons. First, and most obvious, is the possibly high voltages on exposed metal parts of the oscilloscope that present a shock hazard to the operator. Second, and not so obvious, is the cumulative stresses on the oscilloscope power transformer insulation. Such stresses can cause future failure, with attendant shock and fire hazard, even after the oscilloscope is returned to properly grounded operation. From a measurement standpoint the "floated scope" has the problem of imposing a loading effect on the "signal common". This loading is caused by capacitance between the floating scope chassis and the power line which may be considered at ac ground.

COMMON FLOATING MEASUREMENT TECHNIQUES

Floating measurements are made using various techniques, each having advantages and limitations. Some are unsafe, others distort the waveform measurement. Following are three preferred techniques.

Differential Techniques

The most popular solution to the need for a floating measurement is the A minus B quasi-differential technique. Most general-purpose dual-trace oscilloscopes (such as the Tektronix 2445) have an Add Mode in which the two channels (invert CH 2) can be electrically subtracted, giving a display of the difference signal. This can be a problem when attempting to examine low-level control signals in the presence of high common-mode voltages. Also, the common-mode dynamic range is severely limited (±6 divisions beyond screen height) and CMRR is low—approximately 100:1.

True differential amplifiers are specifically designed to have good rejection of the common-mode signal and display only the difference signal. Because these amplifiers are basically two ground-referenced amplifiers, limited floating or common-mode capability is provided. Further, the ability to display a small signal in the presence of a large common-mode signal changes as a function of the absolute magnitude of the common-mode signal, as well as the ratio of the common-mode signal to the difference signal. Also, there are bandwidth limitations. The Tektronix 7A13 provides 500 volts of common-mode dynamic range at 0.1 V/div with a CMRR of at least 1000:1 and a bandwidth up to 105 MHz.

Isolation Amplifiers

The isolating amplifier is connected between the signal under investigation and the oscilloscope. With respect to the signal, the amplifier is completely insulated, with no accessible conductive parts. The signal is coupled across an insulating barrier to the oscilloscope. Use of the isolation amplifier maintains the usability of all scope functions.

The Tektronix A6902A Isolator is an isolation amplifier consisting of two identical amplifiers, isolated from each other, from accessible parts, from the mains, and from ground. It enables an oscilloscope to measure potentials from ±20 mV to ±1500 volts. Each signal common lead can be independently connected to separate voltages up to plus or minus 1500 volts. The A6902A can measure two such signals simultaneously, in combination with any dual trace oscilloscope.

Indirect Grounding

Safety standards specify indirect grounding as an alternative to direct grounding. All of the grounding requirements apply, except that the grounding circuit need not be completed until the available voltage or current exceeds a prescribed amount.

The Tektronix A6901 Ground Isolation Monitor is an indirect grounding device. It is connected between the mains and the test instrument. When activated, it disconnects the protective grounding system and monitors the voltage and current of the isolated ground. If this voltage exceeds 40 volts peak, the A6901 disconnects the power to the test instrument, sounds an alarm, and reconnects the protective grounding conductor.

The A6901 can be used with any grounded test instrument. It also tests ground continuity of the mains and will not activate if the mains ground is inadequate. It solves the problems of defeating the protective ground and provides the means for valid measurements.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

A6901

Permits Elevation of Test Instrument Chassis to 40 V Peak (28 V RMS)

Aids in Circuit Analysis or Circumventing Ground Loop Noise Problems

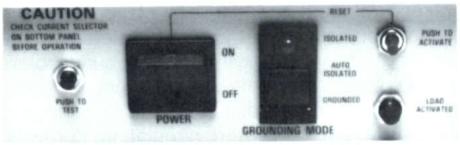
UL and VDE Safety Certification

The A6901 is placed between a measurement instrument and its power source and acts as an indirect grounding device, allowing floating measurements to be made with operator protection.

The A6901 monitors the voltage on the isolated system. When the voltage exceeds 40 V peak (28 V RMS) the power source to the instrument is interrupted, the isolated grounding system is connected to the power source grounding system, and an audible alarm is sounded. Before power is supplied to the measurement instrument, the A6901 tests the power source for a functional ground*[1]. If a functional ground is not established, the ground isolation monitor will not go into isolated mode.

Applications for the A6901 include elevating a test instrument chassis to logic reference voltages for more accurate logic level measurements, and isolating a test instrument chassis from common-mode voltages present on ground systems to eliminate undesirable noise from signal measurements.

*[1] *If the A6901 is used in conjunction with a GFI (Ground Fault Indicator), consult the GFI manual for compatibility information.*



CHARACTERISTICS

ELECTRICAL CHARACTERISTICS

Trip Voltage (Dc) — 40 V peak (28 V RMS) or + and − 40 V (within 5%).

Trip Current — 0.5 mA, 3.5 mA to 5 mA selectable.

Neutral-to-Ground Continuity — Between 3 V and 10 V RMS (8.5 V and 28.3 V p-p), 50 Hz.

Dc Voltage Trip Delay — <20 ms.

Line Voltage Ranges — 90 V to 128 V RMS, 180 V to 250 V RMS.

Line Frequency Range — 48 Hz to 66 Hz.

Maximum Power Consumption (No External Load) — 12 W at 115 V, 60 Hz.

Load Power — 500 W maximum

ENVIRONMENTAL CHARACTERISTICS

Temperature — Operating: −15°C to +55°C (+5°F to +131°F). Nonoperating: −62°C to +85°C (−80°F to +185°F). Meets MIL-T-28800B, Class 3.

Altitude — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft). Exceeds MIL-T-28800B, Class 3.

Humidity — Exceeds MIL-T-28800B, Class 3.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Height	87	3.4
Width	206	8.1
Depth	153	6.0
Weights	**kg**	**lb**
Net (without accessories)	1.4	3.0
Shipping	2.3	5.0

INCLUDED ACCESSORIES

STANDARD INSTRUMENT, NORTH AMERICAN 120 V

17.5 cm IEC male to NA female 120 V load cord (161-0150-00); 3 AF DIN metric fuse (159-0190-00); 3 AG 0.062A SLO fuse (159-0051-00); 3 m NA male to IEC female power cord (161-0066-00); instruction manual.

UNIVERSAL EURO, OPTION A1

17.5 cm IEC male to Euro female 240 V load cord (161-0157-00); 6.3 A DIN metric fuse (159-0202-00); 0.1 A DIN metric fuse (159-0074-00); 3 m Euro male to IEC female power cord (161-0066-09); instruction manual.

UNITED KINGDOM OPTION A2

17.5 cm IEC male to UK female 240 V load cord (161-0159-00); 6.3 A DIN metric fuse (159-0202-00); 0.1 A DIN metric fuse (159-0074-00); 3 m UK male to IEC female power cord (161-0066-10); instruction manual.

AUSTRALIA, OPTION A3

17.5 cm IEC male to Australian female 240 V load cord (161-0158-00); 6.3 A DIN metric fuse (159-0202-00); 0.1 A DIN metric fuse (159-0074-00); 3 m Australian male to IEC female power cord (161-0066-11); instruction manual.

SWITZERLAND, OPTION A5

17.5 cm IEC male to Swiss female 240 V load cord (161-0160-00); 6.3 A DIN metric fuse (159-0202-00); 0.1 A DIN metric fuse (159-0074-00); 3 m Swiss male to IEC female power cord (161-0154-00); instruction manual.

ORDERING INFORMATION

A6901 Ground Isolation Monitor **$450**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz
Option A2 — UK 240 V/13 A, 50 Hz
Option A3 — Australian 240 V/10 A, 50 Hz
Option A5 — Switzerland 220 V/10 A, 60 Hz
(North American 240 V not available. Neutral not grounded in 240 V North American Systems.)

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

NEW

NEW A6902A

Two Independently Isolated Channels

High Voltage/High CMRR

±1500 V/Channel
(3000 V Maximum Differential)

Dc to 20 MHz Bandwidth

User Safety (UL and VDE Certified)

In recognition of the requirement to perform floating measurements and low-level signal measurements in the presence of high-amplitude common-mode voltages, Tektronix offers the A6902A Isolator. It is a dual-channel, optical- and transformer-coupled voltage isolator that allows safely grounded test instruments to make floating measurements at high sensitivity levels in the presence of large common-mode signals.

The A6902A acts as a buffer between the test instrument and the system under test and extends the range of the test instrument to 1500 V (dc plus peak ac) with the larger industrial probe and to 500 V (dc plus peak ac) with the smaller signal probe. Both probes are quickly interchangeable at the cable connectors. The two pairs of probes and output cables are stored in removable side pouches for availability and convenience.

Designed for use with any dual-channel oscilloscope, the A6902A permits simultaneous observation of two signals at two different points in the same circuit; or signals in two different circuits. Separate, calibrated controls for volts per division on each channel provide for precise floating measurements. The all-plastic case and external controls protect the user during control settings and other operations. Other than probe tip connections, the user is never in close proximity to hazardous voltages. The A6902A is certified by worldwide safety agencies which includes UL 1244, VDE, CSA Electronics Bulletin 556B, IEC 348 and BS 4743.

CHARACTERISTICS

ELECTRICAL CHARACTERISTICS

Deflection Factor — Probe Tip Sensitivity: 20 mV/div to 200 V/div in 1-2-5 sequence with oscilloscope set to 10 mV/div. Accuracy: ≤ ±5% of indicated V/div switch setting.

Maximum Working Voltage

Large Probe (1500 V) — Probe Center Tip to Earth Ground: 1500 V (dc + peak ac). Probe Center Tip to Probe Common: 1500 V (dc + peak ac) to 900 kHz. See Figure 1 for voltage derating above 900 kHz. Probe Common to Earth Ground: 1500 V (dc + peak ac) to 420 kHz. See Figure 2 for voltage derating above 420 kHz.

Small Probe (500 V) — Probe Center Tip to Earth Ground: 500 V (dc + peak ac). Probe Center Tip to Probe Common: 500 V (dc + peak ac) to 3 MHz. See Figure 2 for voltage derating above 3 MHz. Probe Common to Earth Ground: 500 V (dc + peak ac) to 6 MHz. See Figure 2 for voltage derating above 6 MHz.

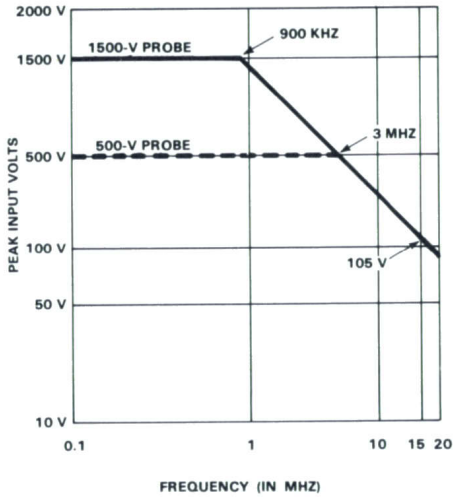


Figure 1. Maximum working voltage between probe input and probe common (all temperatures).

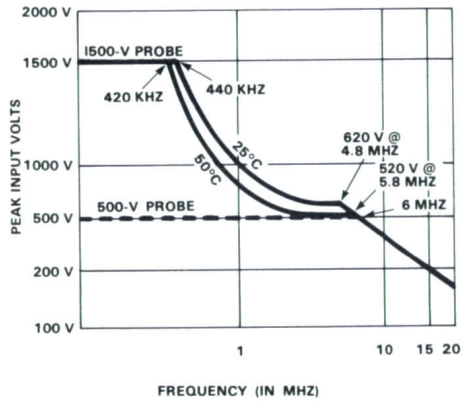


Figure 2. Maximum working voltage between probe common and earth ground.

Frequency Response — Bandwidth: Dc coupled (to −3 dB points) is ≥20 MHz. Ac coupled (to lower −3 dB point) is ≤5 Hz .

Transient Response — Risetime: 17.5 ns (calculated from bw).

Maximum Input dV/dt — 100 V/ns.

Input Impedance — Resistance: 10 MΩ ±3%. Capacitance: ≈19 pF with either probe.

Output Impedance — 50 Ω ±5%.

Output Drive — 250 mV p-p typical.

Common Mode Capacitance — 200 pF from probe common to earth ground.

Tangential Noise — 2.0 mV. Dc Drift With Temperature: ≤1 mV/°C (0.1 div/°C) at output. Range of Output Dc Level: At least +5 div from center screen.

Channel Isolation — Maximum Voltage: Using two 1500 V probes is 3000 V (dc + peak ac). Using two 500 V probes is 1000 V (dc + peak ac).

Delay — 42 ns ±3 ns from probe input to instrument input. CH1, CH2 delay difference is ≤4 ns.

Common Lead Signal Feedthrough — −106 dB from probe input to output BNC to 500 Hz. See Figure 3 for derating above 500 Hz.

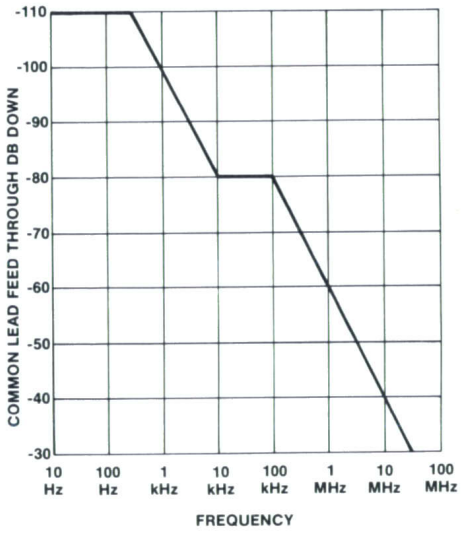


Figure 3. Common-lead feedthrough characteristics.

POWER SOURCE CHARACTERISTICS

Line Voltage Ranges — Low: 90 V to 132 V. High: 120 V to 250 V.

Line Frequency Range — 48 Hz to 440 Hz.

Maximum Power Consumption — 17 W at 115 V, 60 Hz.

ENVIRONMENTAL CHARACTERISICS

Temperature — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

Humidity (Operating and Nonoperating) — 5 cycles (120 hr total) with equipment tested nonoperating to MIL-STD-810C Method 507.1, at 90% to 95% relative humidity and 30°C to 60°C.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Height	136	5.4
Width	394	15.5
Depth	344	13.5
Weight	**kg**	**lb**
Net w/Accessories	6.2	13.2
Shipping	8.0	17.7

INCLUDED ACCESSORIES

Two 1500 V isolation probes (010-0409-01); two 500 V isolation probes (010-0411-10); 0.15 ASB 250 V fuse (159-0054-00); 0.1 ASB 250 V fuse (159-0048-00—Europe); right angle power cord (161-0117-00); two 2 m, 50 Ω output cables (012-0204-00); operator's manual, service manual.

ORDERING INFORMATION

A6902A Isolator **$1,850**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

THE STRONGEST LINK BETWEEN YOUR TEK INSTRUMENT AND RESULTS.

Tek instruments are designed for users who place a premium on equipment quality and on reliability of results. Tek probes are engineered, assembled and tested to provide the most compatible link possible between those instruments and the outside world. Accuracy depends on the accuracy of the data received. Nothing can compensate for the precision of the signal nor an awkward or unsafe operational routine.

PROBES: SELECTION CRITERIA

No factor is more critical to optimized system performance than proper probe selection. A probe that's not right for your application can mean a significant loss in measurement results, plus costly delays and errors.

For over 35 years, Tektronix has been designing probes that are matched not only to our scopes, but to your own instrument and application needs. They minimize circuit loading, while extending and enhancing system performance.

By extending our resistive-wire, center-conductor cable technology, Tek 10X Passive probes can transfer a signal frequency that exceeds 300 MHz and presents only an added 30 pF per meter of cable to a circuit.

Tek probe products include active voltage probes, active and passive current probes, high voltage probes, low impedance/high frequency probes, and differential probes.

Bandwidth/risetime, input voltage, input impedance and limiting aberrations are all characteristics to evaluate in terms of your own application.

While electrical considerations are of major importance in your selection, physical parameters, such as probe length and proper tip adaptor, can be equally crucial. Unnecessary cable length, for example, will decrease bandwidth and increase the loading capacitance of the probe.

You'll find a wide variety of adaptors and probe tips available which feature Tek's special alloy coating that minimizes low current conduction problems. All are inherent to the Tek modular probe concept that lets you snap tips and other probe parts together without tools, so maintenance and repair of damaged probes is of minimal expense.

PROBE TYPES

Current Probes

Current probes provide a method to measure the current flowing in a circuit. For instance, their use can eliminate the calculations that would be required to determine the current from the voltage drop across a current sampling resistor.

Two types of current probes are available, the traditional ac only probe and the "Hall effect" type. Ac only current probes use a transformer to convert current flux into ac signals and have a frequency response from a few hundred hertz to 100 MHz. Hall effect current probes use semiconductors to provide a frequency response from dc to 50 MHz.

A current probe is used by clipping its jaws around the wire that is carrying the current to be measured. Because it is "noninvasive", a current probe imposes less loading than other probes (typically less than a few nanohenrys in series with the wire at a capacitance of less than 1 pF). Differential current measurements are made by passing the two wires (in correct phase) through the current probe jaws.

The CT-5 increases the high-current measuring capability of most current probes by either 20:1 or 1000:1.

Differential Probes

The normal 10X probe has a typical accuracy of ±1%, giving a scope/probe common-mode rejection ratio of no more than 50:1. Using a matched pair of P6055 differential probes, common-mode rejection ratios of 20,000:1 or better can be obtained.

Active Probes

Active components contained in these probes result in high input resistance and low input capacitance without loss of signal. Dynamic range and measurement capability are substantially increased through the voltage offset control.

Since active probes have a selectable 50 Ω output impedance, the distance from the probe tip to the instrument is only limited by the bandwidth limit of the 50 Ω coaxial cable between the probe and instrument.

Z_0 Probes

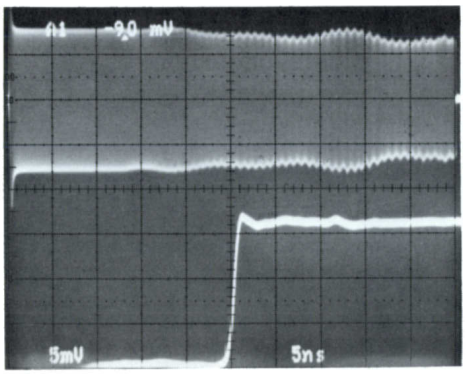
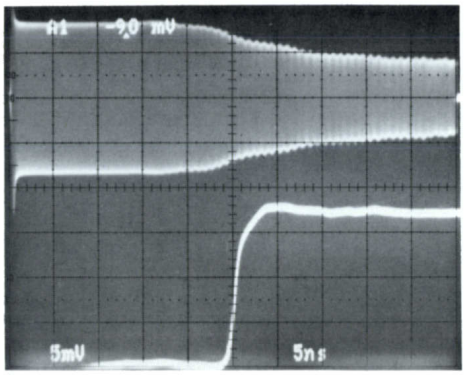
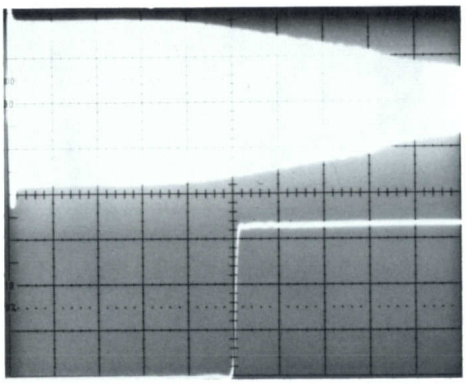
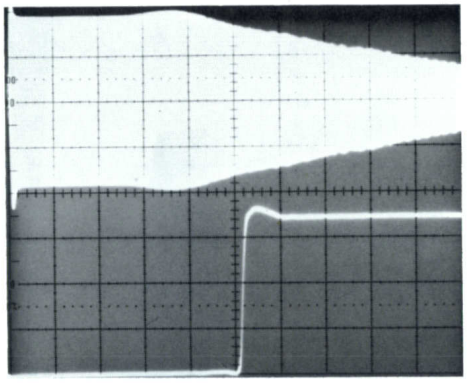
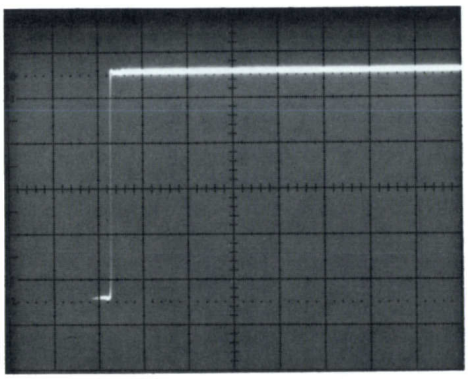
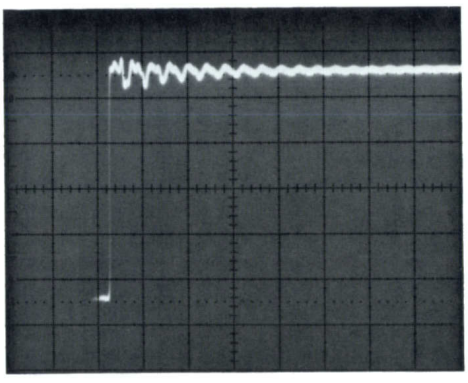
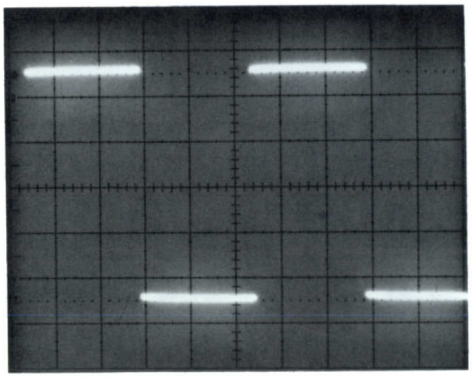
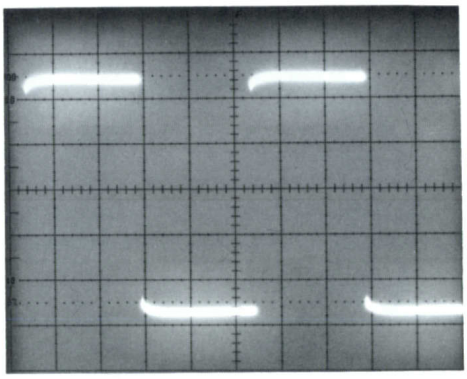
Probes provide the lowest input capacitance (typically 1 pF for high frequency signals) and are used with high frequency, 50 Ω input scopes. Z_0 probes provide the most consistent probe loading because they exhibit a frequency response that is essentially flat.

High Voltage Probes

Several high voltage probes are available from Tektronix that provide 100X or 1000X compensated dividers. Because these probes are primarily designed for high voltage applications, input capacitance is reduced to approximately 3 pF by the high division ratio.

Why Tek Probes—See the Difference

The pictures to the right show signals measured with Tek probes and their commodity counterparts. To get the best performance from your measurement system use Tek probes!

Optimum Performance With Tek	Loss With Commodity Probe
	
Bandwidth: Tek probe transmits clear 300 MHz signal.	*Commodity probe limits same signal to 200 MHz.*
	
Frequency Response: Tek probes evenly matched for clear response.	*Commodity probe peaked resulting in aberrations.*
	
Probe Tip Accessories: Tek offers many accessories to make the "best" measurement possible.	*Commodity probes may not have the right accessory to make a faithful measurement.*
	
Environmental: Tek offers superior performance. No signal degradation after 5 days in high humidity.	*Commodity probe shows "hook" after same humidity test.*

ACTIVE PROBES

Active probes have high input resistance and low input capacitance through their dynamic range.

Used in measurements where high input resistance and low input capacitance is needed and where frequencies above 250 MHz are encountered.

Type	Attn	Nominal Length	Package Number	Loading		Risetime	Input Limits: Maximum Dc + Pk Ac	Input Limits: Linear Dynamic Range	Input Limits: Dc Offset Range	Read-Out	Page
P6230 Bias/ Offset	10X	1.5 m	010-6230-01	450 Ω	1.3 pF	230 ps	±30 V	±5 V	±5 V	YES	442
P6046 Diff/Amp	1X 10X	6 ft	010-0232-00 Std Inc PS & Amp	1 MΩ 10 MΩ	10 pF 3 pF	3.5 ns	±25 V ±250 V	±5 V ±50 V		NO	444
P6201 FET	1X 10X 100X	6 ft	010-6201-01 Std Inc PS & Amp	100 kΩ 1 MΩ 1 MΩ	3 pF 1.5 pF 1.5 pF	0.4 ns	±100 V ±200 V ±200 V	±0.6 V ±6 V ±60 V	±5.6 V ±56 V ±200 V	YES	443
P6202A FET	10X 100X	2 m	010-6202-03 Std W/010-0384-00 Atn	10 MΩ 10 MΩ	2 pF 2 pF	0.7 ns 0.7 ns	±200 V ±200 V	±6 V ±60 V	±55 V ±200 V	YES NO	443

50 Ω DIVIDER PROBES

For use with 50 Ω systems. For risetime measurements, the interaction of the probe capacitance with the source impedance is important (RC time constant). For best results, the capacitance should be kept minimal. Typical probe specifications represent their response to a 25 Ω source environment.

Type	Attn	Nominal Length	Package Number	Loading		Risetime	Input Limits: Maximum Dc + pk Ac	Input Limits: Linear Dynamic Range	Read-Out	Page
P6056	10X	6 ft 9 ft	010-6056-03 Std 010-6056-05	500 Ω	1 pF	0.1 ns	±16 V	±16 V	YES	444
P6057	100X	6 ft 9 ft	010-6057-03 Std 010-6057-05	5 kΩ	1 pF	0.25 ns	±50 V	±50 V	YES	444

CURRENT PROBES

Used to measure currents from dc to 1000 A.

Current probes can be used where low loading of the circuit is necessary. Loading is typically in the mΩ to low Ω range. Current probes can be used for differential measurements; where the probe measures the results of two opposing currents in two conductors in the jaw of the probe.

A current waveform may be very different from a voltage waveform in a current-dependent circuit. Measuring only the voltage will not show this difference. A measurement of the current waveform is necessary to obtain the total picture.

Type	Bandwidth Hz to MHz	Displayed Current/Div	Maximum Current: Peak Pulse	Maximum Current: Dc + pk Ac	Maximum Current: Ac P-P	Derate: Below	Derate: Above	Saturation: Dc	Saturation: Amp-S Product	Page
A6302/ AM 503	Dc 50	1 mA to 5 A*1	50 A	20 A	40 A		1 MHz	20 A	100 x 10^{-6}	447
with CT-5	0.5 20	20 mA to 5 kA*1	50 kA		40 kA	20 Hz	1.2 kHz		0.1	449
A6303/ AM 503	Dc 15	10 mA to 50 A*1	500 A	100 A	200 A		20 kHz	100 A	10,000 x 10^{-6}	447
P6021 w/Passive Term.	120 60	20 mA or 100 mA*1	250 A		15 A	300 Hz	5 MHz	0.5 A	500 x 10^{-6}	448
+ CT-5	120 20	400 A or 100 kA*1	50 kA		2000 A	300 Hz	1.2 kHz	20 A	0.5	449
with 134	12 38	1 mA to 1 A*2	250 A		15 A	230 Hz	5 MHz	0.5 A	500 x 10^{-6}	448
+ CT-5	12 20	20 mA to 1 kA*2	15 kA		2000 A	230 Hz	1.2 kHz	20 A	0.5	449
P6022 w/Passive Term.	935 200	10 mA or 100 mA*1	100 A		6 A	3 kHz	10 MHz	0.2 A	9 x 10^{-6}	448
with 134	100 65	1 mA to 1 A*2	100 A		6 A	1.3 kHz	10 MHz	0.2 A	9 x 10^{-6}	448
CT-1	25 k 1000	0.5 mA*1 (5 mV/mA)	12 A		1.4 A			0.2 A	1 x 10^{-6}	449
CT-2	1.2 k 200	0.1 mA*1 (1 mV/mA)	36 A		7 A			0.2 A	50 x 10^{-6}	449

*1 Scope set at 10 mV/div.
*2 Scope set at 50 mV/div.

OTHER PROBES

Recommended Probes—For 7000 Series see page 236, for 5000 Series see page 284, for others see the individual instrument description.

Probe	Package Number	Function	Use	Page
P6048	010-0215-00	Low Capacitance 1 pF, 1 kΩ	400 Series	444
P6058A	010-6058-01	Temperature and Voltage Probe	DM 501, 7D13	
P6430	010-6430-00	Temperature Probe	DM 44, DM 502	
P6104	010-6104-00	Voltage Probe	465M	
40 kV	010-0277-00	High Voltage Dc Probe	2337, DM 501A, DM 502A	384
P6451	010-6451-03	Data Acquisition Probe	7D01	84
P6401	010-6401-01	Logic Probe	TTL Logic	84, 445
P6406	010-6406-01	Word Recognizer	308	84
P6420	010-6420-03	RF Probe for DMM's	2337, DM 501A, DM 502A, DM 44	446
P6601	010-6601-01	Temperature Probe	DM 501A, DM 502A, 7D13A	384
P6602	010-6602-01	Temperature Probe	2236 DMM	445
P6125	010-6125-01	Digital Counter/Timer Probe, 5X Attenuation	DC 503A, DC 504, DC 505A, DC 508, DC 509	377

PASSIVE PROBES

For amplitude measurements, the capacitance and resistance of the probe form a voltage divider with the circuit under test. For low frequency (about 5 MHz and below), the resistive component is of primary importance in most probes and should be at least two orders of magnitude greater than the circuit source impedance. For higher frequencies (greater than about 30 MHz), the importance of the capacitance increases drastically and will become the prime consideration.

For general-purpose use, passive voltage probes offer a wide probe selection for a variety of applications for 1 MΩ inputs.

Modular probes are an exciting new concept in probe design. The P6101, P6105, P6106, P6107, P6108, P6121, P6122, P6130, P6131 and P6149 Probes divide into three modules (probe heads, cables, and connector/compensation boxes).

VOLTAGE PROBES FOR 1 MΩ INPUTS

MODULAR

TYPE	ATTEN	LENGTH (m)*1	PACKAGE NUMBER	LOADING		USEFUL BW MHz*2*4	DC MAXIMUM	SCOPE C IN pF	READOUT	PAGE
P6101	1X	1.0 2.0 3.0	010-6101-01 010-6101-03 010-6101-05	1 MΩ	32.0 pF 54.0 pF 78.0 pF	34.0 15.5 8.0	500 V	ANY	—	452
P6105	10X	1.0 2.0 3.0	010-6105-01 010-6105-03 010-6105-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	100.0 100.0 95.0	500 V	15 to 47	YES	452
P6106	10X	1.0 2.0 3.0	010-6106-01 010-6106-03 010-6106-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	250.0 250.0 150.0	500 V	15 to 24	YES	452
P6107	10X	2.0	010-6107-03	10 MΩ	13.0 pF	100.0	500 V	15 to 47	YES	453
P6108	10X	1.0 2.0 3.0	010-6108-01 010-6108-03 010-6108-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	100.0 100.0 95.0	500 V	15 to 47	NO	452
P6121	10X	1.5	010-6121-01	10 MΩ	11.0 pF	100.0	500 V	15 to 35	YES	451
P6122	10X	1.5	010-6122-01	10 MΩ	14.0 pF	100.0	500 V	15 to 35	NO	451
P6125	5X	1.5	010-6125-01	5 MΩ	20.0 pF	200.0	250 V	15 to 33	NO	377
P6130	10X	1.5 2.0 3.0	010-6130-01 010-6130-03 010-6130-05	10 MΩ	12.7 pF 13.2 pF 14.5 pF	250.0 250.0 150.0	500 V	15 to 47	YES	450
P6131	10X	1.3 3.0	010-6131-01 010-6131-05	10 MΩ 10 MΩ	10.8 pF 14.5 pF	300.0 150.0	500 V 500 V		YES	450
P6149	10X	2.0	010-6149-03	10 MΩ	15.5 pF	50.0	500 V	20 to 62	NO	453

MONOLITHIC

TYPE	ATTEN	LENGTH (ft)*1	PACKAGE NUMBER	LOADING		USEFUL BW MHz*2*4	DC MAXIMUM	SCOPE C IN pF	READOUT	PAGE
P6006	10X	3.5 6 9 12	010-0127-00 010-0160-00 010-0146-00 010-0148-00	10 MΩ	7.5 pF*2 8.5 pF 11.0 pF 15.0 pF	35.0 25.0 25.0 12.0	600 V	15 to 55	NO	—
P6007	100X	3.5 6 9 12	010-0150-00 010-0165-00 010-0152-00 010-0154-00	10 MΩ	2.0 pF*2 2.2 pF 2.4 pF 2.6 pF	25.0 20.0 15.0 13.0	1.5 kV	15 to 55	NO	454
P6008	10X	3.5	010-0129-00	10 MΩ	7.5 pF	100.0	600 V	12 to 47	NO	—
P6008 (Environmentalized)	10X	6	010-0129-01 Environmentalized −50°C to +150°C	10 MΩ	7.5 pF	100.0	600 V	12 to 47	NO	446
P6009	100X	9 9	010-0170-00 010-0264-01	10 MΩ	2.5 pF 2.5 pF	120.0 100.0	1.5 kV	12 to 47	NO YES	454
P6010	10X	3.5	Furnished with S-5. For other uses see P6105 or P6106.							
P6015	1000X	10	010-0172-00	100 MΩ	3.0 pF	75.0	20 kV	12 to 47	NO	454
P6028	1X	3.5 6 9 12	010-0074-00 010-0075-00 010-0076-00 010-0077-00	1 MΩ	50.0 pF 67.0 pF 90.0 pF 112.0 pF	17.0 10.0 7.0 4.0	600 V	ANY	YES	—
P6048	10X	6	010-0215-00	1 kΩ	1.0 pF	100.0	20 V	15 to 20	NO	444
P6053B	10X	3.5 6 9	010-6053-11 010-6053-13 010-6053-15	10 MΩ	9.5 pF 12.5 pF 13.5 pF	200.0 200.0 115.0	500 V	15 to 24	YES*5	455
P6055*3	10X	3.5	010-6055-01	1 MΩ	10.0 pF	60.0	500 V	20 to 47	YES	455
P6060	10X	3.5 6	010-6060-01 010-6060-03	1 MΩ	7.5 pF*2 8.5 pF	35.0 25.0	500 V	15 to 55	YES	—
P6062B	10X or 1X 10X or 1X 10X or 1X	3.5 6 9	010-6062-11 010-6062-13 010-6062-15	10 MΩ 1 MΩ 10 MΩ 1 MΩ 10 MΩ 1 MΩ	13.5 pF 100.0 pF 14.0 pF 105.0 pF 17.0 pF 135.0 pF	100.0 8.0 100.0 6.0 95.0 4.5	500 V	15 to 47	YES	455
P6063B	10X or 1X 10X or 1X	3.5 6	010-6063-11 010-6063-13	10 MΩ 1 MΩ 10 MΩ 1 MΩ	11.0 pF 80.0 pF 14.0 pF 105.0 pF	200.0 12.0 200.0 6.0	500 V	15 to 24	YES	455

*1 All lengths are nominal and measured electrically for optimum performance.

*2 Rating varies with scopes having other than 20 pF inputs.

*3 Designed for use with scopes having differential inputs.

*4 25 Ω source.

*5 Trace identification button.

PROBE/INSTRUMENT COMPATIBILITY

For quick reference only to suggest some of the possible probe/instrument combinations. Check probe descriptions on the following pages for more information or call your Tektronix Sales Representative or the Tek National Marketing Center for assistance.

INSTRUMENT	PROBES		
	PASSIVE	ACTIVE	CURRENT
7000 SERIES			
7A11	Built in FET Probe		A6302/AM 503 A6303/AM 503
7A13	P6055 P6015 P6101 P6009 P6062B P6105 P6122		P6021 P6022
7A15A	P6101 P6015 P6105 P6009 P6062B P6122 P6130		P6021 P6022
7A16A	P6106 P6015 P6101 P6009 P6063B P6130	P6201 P6202A	P6021 P6022 A6302/AM 503
7A18A	P6101 P6015 P6105 P6009 P6062B P6122 P6130	P6202A	P6021 A6302/AM 503
7A19	P6056 P6057	P6201 P6202A	A6302/AM 503 A6303/AM 503
7A22	P6101 P6055 P6062B		P6021 A6302/AM 503
7A24	P6056 P6057	P6201 P6202A	A6302/AM 503 A6303/AM 503
7A26	P6063B P6015 P6048 P6009 P6130	P6201 P6202A	P6022 A6302/AM 503 A6303/AM 503
7A29	P6056 P6057	P6201 P6202A	A6302/AM 503 A6303/AM 503
7A42	P6131	P6230	
7D12	P6055		
7D13A	P6601 P6420 40 kV(010-0277-00)		
7D20	P6053B		
5000 SERIES			
5A14N **5A15N** **5A18N**	P6101 P6015 P6108 P6007 P6062B		P6021 A6302/AM 503
5A21N **5A26**	P6101 P6055 P6062B		P6021
5A22N	P6101 P6055 P6062B		
5A38 **5A45** **5A48**	P6101 P6015 P6105 P6009 P6062B P6122		P6021 P6022 A6302/AM 503
5D10	P6101 P6105 P6007 P6015 P6062B		P6021
TM 500 SERIES			
AM 502	P6055 P6101		P6021
AM 503			A6302 A6303
DM 501A **DM 502A** **DM 505**	P6420 40 kV(010-0277-00) P6601		
DC 503A **DC 504** **DC 505A** **DC 509**	P6125 P6108 P6122 P6101	P6201	

INSTRUMENT	PROBES		
	PASSIVE	ACTIVE	CURRENT
TM 500 SERIES			
DC 508A	P6125 P6056 P6108	P6230	
DC 510	P6125 P6056		
PG 501 **PG 507** **PG 508**	P6122 P6062B P6101 P6108		
PG 502	P6130 P6062B P6101		
SC 501 **SC 502** **SC 503**	P6101 P6062B P6108 P6007 P6015		P6021
SC 504	P6101 P6062B P6108 P6009 P6015 P6122		P6021 P6022
TM 5000 SERIES			
DC 5009	P6125 P6122		
DC 5010	P6125 P6056 P6130	P6201 P6202A	
SI 5010	P6056 P6057	P6201 P6202A	A6302/AM 503
400 SERIES			
485	P6101 P6015 P6106 P6009 P6056 P6048 P6057 P6130 P6063B	P6201 P6202A P6230	P6021 P6022 A6302/AM 503 A6303/AM 503
475A **475**	P6101 P6015 P6106 P6009 P6063B P6048 P6130	P6201 P6202A	P6021 P6022 A6302/AM 503 A6303/AM 503
465B **465** **468**	P6101 P6015 P6105 P6009 P6062B P6048 P6130	P6201 P6202A	P6021 P6022 A6302/AM 503 A6303/AM 503
465M	P6101 P6015 P6104 P6009 P6130	P6201 P6202A	P6021 P6022 A6302/AM 503 A6303/AM 503
455	P6101 P6015 P6105 P6009 P6062B	P6202A	P6021 P6022 A6302/AM 503 A6303/AM 503
466 **464**	P6101 P6015 P6105 P6009 P6062B P6130	P6201 P6202A	P6021 P6022 A6302/AM 503 A6303/AM 503
434	P6101 P6108 P6105 P6009 P6015		P6021 P6022 A6302/AM 503 A6303/AM 503

INSTRUMENT	PROBES		
	PASSIVE	ACTIVE	CURRENT
300 SERIES			
308	P6107	P6404 P6451	
305, 314, **323, 326,** **335, 336**	P6101 P6149		P6021, P6022 A6302/AM 503 A6303/AM 503
390AD	P6101 P6105 P6062B P6015 P6122		P6021 P6022
T900 SERIES			
T935A **T932A** **T922R** **T921** **T912**	P6101 P6122 P6108 P6062B P6009*1 P6007*2 P6015 P6006		P6021 A6302/AM 503 A6303/AM 503
2200 SERIES			
2213 **2215**	P6122 P6101 P6015 P6009		P6021, P6022 A6302/AM 503 A6303/AM 503
2235	P6122 P6015 P6101 P6009		P6021, P6022 A6302/AM 503 A6303/AM503
2236	P6121 P6015 P6101 P6009 P6602		P6021, P6022 A6302/AM 503 P6303/AM 503
2300 SERIES			
2335 **2336**	P6101 P6108 P6009 P6015 P6063B P6130	P6202A	P6021 P6022
2337	P6101 P6108 P6009 P6015 P6063B P6130 P6420 40 kV(010-0277-00)	P6202A	P6021 P6022
2400 SERIES			
2445 **2465**	P6131 P6015 P6101 P6009	P6201 P6202A P6230	A6302/AM 503 A6303/AM 503

*1 *For T935A and T932A only*

*2 *For T922R, T921 and T912 only*

NEW

P6230

Dc to 1.5 GHz Bias/Offset

Bias/Offset from −5 V to +5 V

Internal/External 50 Ω Termination Switch—Use on Scopes with 50 Ω or 1 MΩ Input

Low Impedance

Adjustable Tip "Nulling" Voltage

Fully Compatible with Tek Subminiature Probe Accessories

UL Listed

The P6230 is a 1.5 GHz, low-impedance, subminiature, 10X active probe for use with broad-band oscilloscopes. The P6230 is equipped with an internal/external 50 Ω termination switch which allows the probe to be used on scopes having an input resistance of either 50 Ω or 1 MΩ. A coding pin on the BNC connector activates the Volts/Division reading by 10X, on oscilloscopes equipped with this feature, so that the correct deflection factor at the probe tip is indicated.

The compensation box of the P6230 houses an active circuit which provides a variable voltage at the probe tip. This voltage is used to minimize probe-loading effects. The voltage available at the tip of the P6230 spans the range from minus five volts to plus five volts, allowing the probe to minimize loading effects on most logic families that are in use today.

The P6230 acts as a standard 500 Ω passive voltage probe with the additional capability of having an adjustable tip "nulling voltage." This feature reduces the dc-loading effects of the probe when it is used to measure signals whose mid-voltage value is other than zero volts, or in circuits where the termination impedance is returned to other than ground level. The Input Bias/Offset Voltage may be adjusted so that at a particular test-signal voltage both ends of the probe input-resistor are at equal potentials and no current is flowing through the resistor.

The advantages become very apparent in examining the loading effects on a logic family such as ECL. ECL logic is most commonly operated from a −5.2 V supply with Vcc connected to ground. The output of an ECL gate is the emitter of an NPN emitter follower stage. The output is pulled down to a negative supply (about −2 V) with an external resistor (50 to 100 Ω). Since speed is a major consideration in ECL designs, the interconnections between gates are often transmission lines, and the pull-down resistor doubles as a line termination.

If a standard 500 Ω, 10X probe without the Input Bias/Offset feature were used to examine an ECL output, the probe's 500 Ω resistance to ground would form a voltage divider with the gate's output-termination resistor. This divider can cause severe distortion of the output signal levels, shift the dc-operation point of the output transistor, and greatly reduce the gate's noise margin.

The dc-load nulling capability of the P6230 solves this problem. By adjusting the Input Bias/Offset Voltage to the ECL low level or to the termination voltage, the only effect of the probe resistance will be a small decrease in the ECL output-termination resistance. The effect of the probe on output voltage levels is negligible.

The probe derives its power from the probe power jack on many Tek scopes or a 1101 Power Supply.

CHARACTERISTICS

ELECTRICAL CHARACTERISTICS

Attenuation — 10X ±3%.

Loading — 1.3 pF/450 Ω.

Bandwidth — 1.5 GHz.

Dc Offset Range — −5 V to +5 V.

Dc Maximum — 10 V.

ENVIRONMENTAL CHARACTERISTICS

Temperature Range — Operating: 0°C to +50°C (+32°F to +122°F). Nonoperating: −55°C to +75°C (−67°F to +167°F).

Humidity — 5 cycles (120 hr) 95% to 97% at 30°C to 60°C. MIL-E-16400F, Class 4.

Altitude — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

INCLUDED ACCESSORIES

Alligator ground lead (195-1870-01); microhook ground lead (195-4104-01); low inductance ground lead (195-4240-00); two white marker bands (334-2794-01); two gray marker bands (334-2794-03); protective pouch (016-0708-00); retractable hook tip (013-0208-00); two red marker bands (334-2794-06); two green marker bands (334-2794-07); probe connector (131-2766-03); probe holder (352-0687-00); instruction manual.

P6230 10X 1.6 m
Order 010-6230-01 ..... **$385**

OPTIONAL ACCESSORIES

Probe to BNC Adaptor — Order 013-0195-00 ..... **$9.00**

50 Ω Probe to GR Adaptor — Order 017-0520-00 .... **$48.00**

100 ECB Test Points — Order 131-2766-01 ..... **$18.00**

100 ECB Test Connectors — Order 136-0352-02 ..... **$19.25**

Subminiature to Miniature Adaptor —
Order 013-0202-00 ..... **$3.00**

The following are used with 013-0202-00.

Miniature to BNC Adaptor — Order 013-0084-01 ..... **$8.00**

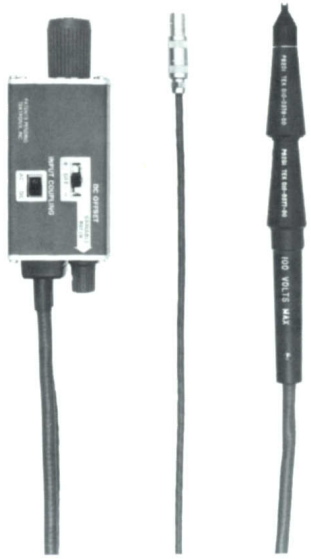
50 Ω Miniature to GR Adaptor —
Order 017-0088-00 ..... **$50.00**

Miniature to Square Pin Adaptor —
Order 015-0325-00 ..... **$13.00**

Microcircuit Pincer Tip — Order 206-0222-00 ..... **$3.50**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

P6201 Dc to 900 MHz



Unity Gain

Two Plug-on Attenuator Heads that Maintain Scope Readout Factor

Low Input Capacitance

Dc Offset

Ac-Dc Coupling Switch

The P6201 is an active (FET) probe providing unity gain and dc to 900 MHz bandwidth. The P6201 is the best general-purpose probe within its voltage range from the standpoint of electrical performance. Very low input capacitance permits acquisition of high frequency signals with minimum loading of circuits under test while high input resistance minimizes low frequency and dc loading. Plug-on attenuator heads provide higher input resistance and reduced input capacitance.

The probe derives its power from the probe power jack on many Tek scopes or a 1101 Power Supply.

CHARACTERISTICS

	P6201	P6202A
Risetime	<0.4 ns	<0.7 ns
Bandwidth (verified by risetime)	>900 MHz	>500 MHz
Attenuation	X1	X10
Attenuation Accuracy	±3%	±4%
Input Resistance	100 kΩ	10 MΩ
Input Capacitance	3 pF	2 pF
Input R with Attenuator	1 MΩ	10 MΩ*1
Input C with Attenuator	1.5 pF	2 pF*1
Dynamic Range	±0.6 V	±6.0 V
Dynamic Range with Attenuator	±6 V or ±60 V	±60 V*1
Dc Offset Range	±5.6 V	±55 V
Noise	300 μV	150 μV
Maximum Input Probe Only	±100 V peak	±200 V peak
Derated above	60 MHz	2 MHz
Derated to—at Frequency	5 V at 500 MHz	20 V at 300 MHz
Maximum Input with Attenuator	200 V peak	200 V peak*1
Derated above	50 MHz	150 MHz*1
Derate to—at Frequency	5 V at 500 MHz	70 V at 400 MHz*1
Ac Coupling—3 dB Low Frequency	10 Hz	16 Hz

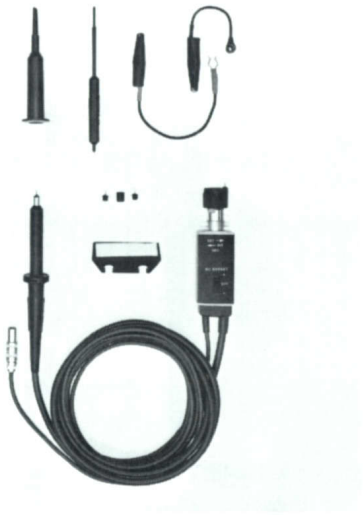
1 Optional accessory.

P6201 INCLUDED ACCESSORIES

Retractable probe tip (CG, 013-0135-00); 10X attenuator head (010-0376-00); 100X attenuator head (010-0377-00); 3 probe tips (CO, 206-0200-00); probe tip (CJ, 103-0164-00); 30 cm (12 inch) ground lead (DB, 175-0848-02); ground contact (CM,131-1302-00); alligator clip (AS, 344-0046-00); electrical insulating sleeve (CK, 166-0557-00); ground contact insulator (CL, 342-0180-00); carrying case (016-0156-02); instruction manual.

P6201 FET Probe
Order 010-6201-01 ..... **$1,145**

P6202A Dc to 500 MHz



Dc Offset

High Input Impedance through Freq Range

Small Probe Size

With its standard Tektronix power connector the P6202A can be used on any instrument that has standard probe power. The very low input capacitance of the probe permits acquisition of high frequency signals with a minimum loading of circuits under test while the high input resistance minimizes low frequency and dc loading.

The probe has a dc offset feature to offset any dc component within the range of the control to bring the signal into the dynamic range of the probe.

The P6202A derives its power from the probe power jack on many of Tek scopes or a 1101 Power Supply.

INCLUDED ACCESSORIES

Retractable probe tip (CB, 013-0097-01); two alligator clips (AS, 344-0046-00); probe holder (352-0351-00); 7.5 cm (3 inch) ground ground (DC, 175-0849-00); probe adjustment tool (CP,003-0675-01); carrying case (016-0378-00); 13 cm (6 inch) ground lead (DE, 175-1017-00); two replaceable probe tips*1; electrical insulating sleeve (BP, 166-0404-01); instruction manual.

1 Available in package of 10 only. Order 206-0230-03 (CF).

P6202A FET Probe, 2 Meter Cable
Order 010-6202-03 ..... **$615**

OPTIONAL ACCESSORIES

P6202A — 10X Attenuator. Order 010-0384-00 ..... **$70**

P6202A — Ac Coupling Cap. Order 010-0360-00 ..... **$34**

1101 Power Supply

The 1101 Accessory Power Supply provides power for active probes such as the Tektronix P6201, P6202A and P6230 when they are used with oscilloscopes that do not have a probe power supply.

The 1101 will provide power for up to four probes. Output power features short-circuit protection. A platform base provides storage for the power cord.

CHARACTERISTICS

Output Voltages — +15 V dc ±0.75%; −15 V dc ±1.5%; +5 V dc ±2.0%.

Output Currents — 400 mA each supply (short-circuit protected).

Ripple — ≤1 mV with 400 mA load (each supply).

Ac Input Voltages — Selectable, 90 to 136 V ac or 180 to 272 V ac.

Line Frequency — 50 Hz to 400 Hz.

Power — High Range: 39 W (390 mA) maximum at 115 V ac, 60 Hz. Low Range: 47 W (455 mA) maximum at 115 V ac, 60 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	132	5.3
Height	79	3.1
Depth	209	8.3
Weight	**kg**	**lb**
Net	1.6	3.5

Order 1101 Accessory Power Supply **$560**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

P6046 Dc to 100 MHz Differential

1000:1 CMRR at 50 MHz

±250 V Maximum Voltage with 10X Attenuator

Dual Probe Tips for Greater CMRR at High Frequencies

The P6046 Differential Probe and P6046 Amplifier Unit provide unique measurement capabilities with all Tektronix oscilloscopes. The differential-signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators.

CHARACTERISTICS

CMRR — With deflection factors of 1 mV/div to 20 mV/div: at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz, and 1,000:1 at 50 MHz. **Common-Mode Linear Dynamic Range** — ±5 V, ±50 V with 10X attenuator. **Bandwidth** — Dc to 100 MHz (−3 dB). **Risetime** — 3.5 ns or less. **Deflection Factor Range** — 1 mV/div to 200 mV/div in 8 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 10 mV/div). **Input RC** — 1 MΩ paralleled by 10 pF or less. **Input Coupling** — Ac or dc, selected by a switch on the probe. Low frequency response ac-coupled is −3 dB at 20 Hz, 2 Hz with 10X attenuator. **Displayed Noise** — 280 μV or less (tangentially measured). **Maximum Input Voltage** — ±25 V (dc + peak ac), ±250 V with 10X attenuation, derated with frequency. **Output Impedance** — 50 Ω through a **BNC**-connector. 50 Ω termination supplied with amplifier for use with 1 MΩ systems. **Probe Cable** — 6 ft long, terminated with special nine-pin connector.

INCLUDED ACCESSORIES

50 Ω termination (BR, 011-0049-01); amp and power supply (015-0106-00); 50 Ω coaxial cable (012-0076-00); hanger assembly (014-0029-00); carrying case (016-0111-01); 10X attenuator (010-0361-00); dual attenuator head (010-0361-00); swivel probe tip; spring ground contact; connector test point jack; instruction manual.

ORDERING INFORMATION

P6046 FET Differential Probe, Amplifier and Power Supply. Order 010-0232-00 ..... **$1,725**

Without Amplifier and Power Supply
Order 010-0213-00 ..... **$900**

Power Supply with Amplifier
Order 015-0106-00 ..... **$850**

P6056 Dc to 3.5 GHz 10X 500 Ω
P6057 Dc to 1.4 GHz 100X 5000 Ω

Low Capacitive Loading, 1 pF or Less

For 50 Ω Wide Band Scopes

<70 ps Probe to Probe Variation

The P6056 is a miniature low-capacitance probe for use with 50 Ω wide-band oscilloscopes. Bandwidth is dc to 3.5 GHz. This probe can also be used with 50 Ω sampling systems, with an appropriate BNC adaptor. The P6056 is equipped with a special BNC connector that provides trace identification and CRT Readout information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function.

CHARACTERISTICS

	P6056	P6057
Risetime	<100 ps	<250 ps
Input R @ Dc	500 Ω	5 kΩ
Input R @ 1 GHz	300 Ω	1500 Ω
Maximum Dc + Peak Ac	16 V	50 V
Derated Above	800 MHz	500 MHz
Maximum Peak @ 1 GHz	9 V	21 V
Maximum Peak Pulse	500 V <1 ms	500 V <1 ms

INCLUDED ACCESSORIES

Alligator clip (AS, 344-0046-00); 75 mm (3 inch) ground lead (DA, 175-0249-00); hook probe tip (BU, 206-0114-00); probe bayonet tip (BM, 013-0085-00); electrical contact (BQ, 214-0283-00); instruction manual.

ORDERING INFORMATION

P6056 10X, 50 Ω Probe
6 ft — Order 010-6056-03 ..... **$165**
9 ft — Order 010-6056-05 ..... **$165**

P6057 100X, 50 Ω Probe
6 ft — Order 010-6057-03 ..... **$170**
9 ft — Order 010-6057-05 ..... **$170**

Included Accessories with double alpha codes are pictured on pages 456 and 457.

P6048 Dc to 200 MHz 10X

Minimum Loading 1 pF to 1 kΩ

Ac/dc Switch

The P6048 is a miniature low capacitance probe for use with 1 MΩ 20 pF oscilloscopes. The probe input impedance of 1 kΩ paralleled by 1 pF is intended for applications where capacitor loading may distort the circuit waveforms. Ac or dc coupling switch is available to extend the measurement range.

CHARACTERISTICS

Attenuation — 10X.
Input Resistance — 1 kΩ.
Input Capacitance — 1 pF or less.
Maximum Input — Dc 20 V; ac 200 V.
Ac Low Frequency — 7 kHz or less.
Bandwidth — (With 250 MHz oscilloscope with 1 MΩ/20 pF input) 175 MHz.
Typical Probe Risetime — 1.95 ns.

INCLUDED ACCESSORIES

Bayonet probe tip (BM, 013-0085-00); retractable probe hook tip (CA, 013-0090-00); two electrical insulating sleeves (BP,166-0404-01); two alligator clips (AS, 344-0046-00); 13 cm (5 inch) ground lead (175-0124-01); insulating sleeve ground lead (CN, 166-0433-00); probe tip hook (BU, 206-0114-00); 7.5 cm (3 inch) ground lead (DD, 175-0263-01); probe holder (352-0090-00); instruction manual.

P6048 10X Probe, 6 ft
Order 010-0215-00 ..... **$205**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

NEW

NEW P6602
Temperature Probe

UL Listed

The P6602 Temperature Probe is a temperature measuring device designed to operate with the 2236 Digital Multimeter. The temperature sensory element consists of a thin-film platinum resistor in the tip of the probe. Measurements are made by touching the probe tip to the surface under test. The resulting resistor value is measured by the multimeter through a two-conductor cable. The tip and cable assembly are replaceable.

CHARACTERISTICS

Operating Temperature Range — Probe Head and Cable: −62°C to +230°C (−80°F to +446°F). Banana Jack Style Connector: −15°C to +85°C.

Voltage — 400 V peak.

Included Accessory — Instruction manual.

P6602 Temperature Probe
Order 010-6602-00 ..... **$235**

P6401 Logic Probe

Illuminated Probe Tip Indicates Logic Level

The small, lightweight, hand-held P6401 indicates the state of logic levels in TTL, DTL, or any other system with threshold between 0.7 and 2.15 volts. A strobe input can be used to detect the coincidence of logic signals at two points. An indication of whether a logic pulse has or has not occurred can be obtained in a "store" mode.

Power may be obtained from the unit under test or any five volt supply.

Two bright lights in the probe tip indicate condition of the logic signal.

CHARACTERISTICS

POWER SUPPLY

Low State Input Voltage Range — 0 V to +0.7 V ±0.125 V.

High State Input Voltage Range — 2.175 V ±0.125 V to V cc.

Minimum Recognizable Pulse Width — 10 ns.

Impedance — ≈7.5 kΩ paralleled by ≈6 pF.

Minimum Circuit Resistance for Open Circuit Indication — 10 kΩ.

Maximum Safe Input — ±150 V (dc or RMS).

Minimum Recognizable Strobe Pulse Width — 20 ns.

Maximum Safe Strobe Input — ±30 V (dc or RMS).

Strobe Input Impedance — 5.6 kΩ within 20%.

Cable Length — 1.5 m (5 ft).

INCLUDED ACCESSORIES

Probe tip hook (BU, 206-0114-00); strobe lead (175-0958-01); strobe lead (175-0958-00); probe tip to 0.025 inch square pin adaptor (AH, 206-0137-01); white plug (348-0023-00); two alligator clips (AS, 344-0046-00); accessory pouch (016-0537-00); instruction manual.

P6401 Logic Probe
Order 010-6401-01 ..... **$160**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

P6420 RF Probe

10 kHz to 1 GHz Bandwidth

Dc V output/RMS of Sine Input

The P6420 RF probe measures high frequency ac voltage from 10 kHz to 1 GHz. It provides a dc output voltage proportional to the RMS value of a sinewave input compatible with any DMM with an input resistance of 10 MΩ.

CHARACTERISTICS

Voltage Range — 0.5 V to 25 V RMS (70.7 V p-p).

Ac to Dc Transfer Ratio Accuracy — 0.5 V to 5 V RMS ±10% (+15°C to +35°C). 5.0 V to 25 V RMS ±5% (+15°C to +35°C).

Frequency Response — 100 kHz to 300 MHz (±0.5 dB). 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB).

Input Capacitance — ≈3.7 pF.

Maximum Input Voltage — 42.4 V (peak ac + dc).

Temperature Range — Nonoperating: −55°C to +75°C. Operating: +15°C to +35°C.

Length — Probe Only: 96 mm. Cable Only: 2 m.

INCLUDED ACCESSORIES

Retractable probe tip (CB, 013-0097-01); two alligator clips (AS, 344-0046-00); two replaceable*[1] probe tips; electrical insulating sleeve (BP, 166-0404-01); 75 mm (3 inch) ground lead (DC, 175-0849-00); 130 mm (6 inch) ground (DE, 175-1017-00); probe holder (352-0351-00); BNC female to dual banana adaptor (103-0090-00); instruction manual.

*[1] *Available in package of 10 only. Order 206-0230-04 (CF).*

ORDERING INFORMATION

P6420 RF Probe (with 2 m Cable)
Order 010-6420-03 ..... **$138**
For a 1 meter length cable only (does not change specifications)
Order 175-1661-00 ..... **$27**
For a 3 meter length cable only (does not change specifications)
Order 175-1661-02 ..... **$27**

Included Accessories with double alpha codes are pictured on pages 456 and 457.

P6008 (Environmental) 10X 100 MHz

−50°C to +150°C Temperature Range

The P6008 Environmental Probe is designed to operate over −50°C to +150°C for the probe body and cable; the compensation box operates from −15°C to +55°C. It is designed for use with Tektronix dc to 100 MHz oscilloscopes. The probe can be compensated to match Tektronix plug-ins and oscilloscopes with nominal input capacitance of 12 pF to 47 pF and input resistance to 1 MΩ.

CHARACTERISTICS

Attenuation — 10X.

Input Resistance — 10 MΩ.

Input Capacitance — ≈7.5pF when used with an instrument having a 20 pF input capacitance.

Bandwidth — Dc to 100 MHz.

Voltage Rating — 600 V dc, ac peak, or dc and ac peak combined. P-p voltage derating is necessary for cw frequencies higher than 20 MHz. At 40 MHz, the maximum allowable p-p voltage is 300 V.

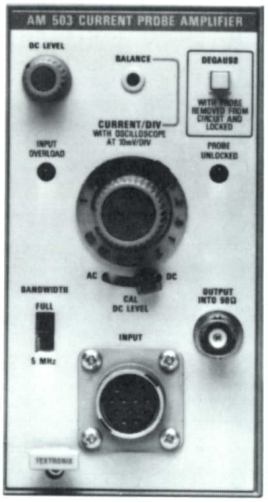
Cable Length — 1.8 m (6 ft).

INCLUDED ACCESSORIES

Banana tip (AK, 134-0013-00); 300 mm (12 inch) ground lead (BD, 175-0125-01); alligator clip (AR, 344-0045-00); retractable hook tip (AP, 013-0071-00); instruction manual.

P6008 Environmental 10X Probe
Order 010-0129-01 ..... **$220**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.



A6302/AM 503 Current Probe

20 A Ac and Dc Current Measurements

Dc to 50 MHz Bandwidth

Peak Pulse Measurements to 50 A, 50,000 A with the CT-5 Current Probe

Ac or Dc Coupling

Small Loading—0.1 Ω Insertion Z at 1 MHz, 0.5 Ω at 50 MHz

The Tektronix A6302 and A6303 Current Probes are designed to be used with the AM 503 Current Probe Amplifier, any TM 500 Power Module and an oscilloscope. Both probes are used to make SCR, power supply, industrial control and motor start-up current measurements. The A6303 is especially recommended for measuring current in x-ray tubes to ensure compliance with PL 90-602, the Radiation Control for Health and Safety Act of 1968.

The A6302 and A6303 are valuable measurement tools when low loading is important, as when testing high impedance points or with current dependent devices.

Both probes make ac or dc coupled current measurements by the simple act of opening their sliding jaws and placing them around the conductor to be measured. For differential or sum measurements just place properly phased conductors in the probe jaw.

Suggested measurements for the A6302 and A6303 Current Probes include:
X-ray tube currents
SCR currents
Power supply currents
Motor start-up currents
Industrial control currents
Relay currents
Common-mode rejection of dc and ac currents

A6303/AM 503 Current Probe

100 A Ac and Dc Current Measurements

Peak Pulse Measurement to 500 A

Ac or Dc Coupling

25 x 21 mm (1 x 0.83 inch) Jaw Opening

Minimal Loading—0.02 Ω Insertion at 1 MHz, 0.15 Ω at 15 MHz

CHARACTERISTICS

	A6302 & AM 503	A6303 & AM 503
Sensitivity Scope @ 10 mV/div Accuracy 3%	1 mA/div to 5 A/div	10 mA/div to 50 A/div
Bandwidth	Dc to 50 MHz	Dc to 15 MHz
Risetime	7 ns	23 ns
Max Ac Current CW	40 A p-p	200 A p-p
Derated above	20 kHz 2.5 A @ 10 MHz	20 kHz 12 A @ 10 MHz
Maximum Current Peak Not to Exceed A-S product	50 A	500 A
A-S Product	100 x 10^{-6}	10,000 x 10^{-6}
Insertion Z	0.1 Ω @ 5 MHz 0.5 Ω @ 50 MHz	0.02 Ω @ 1 MHz 0.15 Ω @ 15 MHz
Max Hardware Volts	500 V	700 V
Max Conductor Diameter	0.15 inch	0.83 inch
System Prop Delay	≈30 ns	≈40 ns
Cable Length	2 m	2 m
Noise	0.3 mA	3 mA
Aberrations	±3%	±5%
Magnetic Sweepability	250 μA/Gauss	25 mA/Gauss
Operating Temp	0°C to +50°C	0°C to +50°C

INCLUDED ACCESSORIES

A6303 only: carrying case (016-0622-00); instruction manual. A6302 only: miniature alligator clips (AS, 344-0046-00); 130 mm (5 in) probe ground lead (DD, 175-0124-01); 75 mm (3 in) probe ground lead (DD, 175-0263-01); instruction manual.

ORDERING INFORMATION

A6303 Current Probe **$1,010**
A6302 Current Probe **$530**

AM 503 Current Probe Amplifier

The AM 503 Current Probe Amplifier operates in any one of the TM 500 power modules and is connected to either the A6302 or A6303 probes through a multi-pin connector.

It is calibrated in 12 steps; the knob skirt is illuminated to indicate current per division. Bandwidth can be limited to 5 MHz to eliminate unwanted transients. Both ac and dc coupling are provided. Ac coupling allows the measurement of low amplitude signals on a high-level dc current. A front-panel light warns of input currents above 100 A dc with the A6303 or 20 A dc with the A6302. A push button allows degaussing of probe when it is removed from the circuit and locked in operating position.

The output of the A6303/AM 503 can be displayed on any oscilloscope that has at least a 50 MHz bandwidth and a 10 mV sensitivity. The A6302/AM 503 can be used on a 75 MHz oscilloscope with 10 mV sensitivity to display the probe's full bandpass. The AM 503 output can be plugged directly into a 50 Ω recording instrument, or a 50 Ω termination which is supplied. See page 392 for a complete description of the AM 503.

INCLUDED ACCESSORIES

50 Ω BNC cable (012-0057-01); 50 Ω BNC termination (BR, 011-0049-01); instruction manual.

ORDERING INFORMATION

AM 503 Current Probe Amplifier **$1,060**

The AM 503 Current Probe Amplifier requires one of the TM 500 Series power modules listed below. The number of plug-ins the module will accept is designated by the last digit in the part number. The optional interface allows connections between plug-ins to be made through the rear panel of the power module.

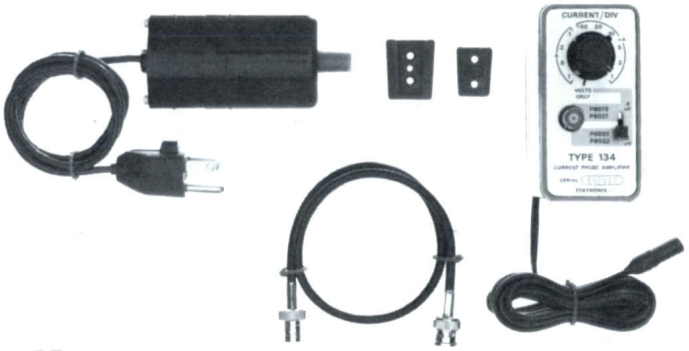
TM 501 Power Module **$340**
Option 02 — Interface ..... **+$60**
TM 503 Power Module **$340**
Option 02 — Interface ..... **+$85**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

P6021 w/Term

P6022 w/Term

134 Current Probe Amplifier



The 134 is used to extend the measurement capabilities and sensitivity of the P6021 or P6022 Current Probe. A Current/Div switch provides calibrated current steps from 1 mA/div to 1 A/div (with the oscilloscope or plug-in unit adjusted for a deflection factor of 50 mV/div). A passive termination is not required when using a 134 with a P6021 or P6022.

The 134 can also be used as an auxiliary voltage amplifier by placing the Current/Div switch in the Volts position.

INCLUDED ACCESSORIES (134)

Hanger assembly (014-0029-00); 110 V power supply (015-0058-01); cable assembly (012-0104-00); 230 V power supply (015-0059-01); instruction manual.

INCLUDED ACCESSORIES (P6021 and P6022)

13 cm (5 inch) ground lead (DD, 175-0125-01); two alligator clips (AS, 344-0046-00); 7.5 cm (3 inch) ground lead (DD,175-0263-01); instruction manual.

Clip-on Capability

Shielded Probe Heads

The P6021 and P6022 Current Probes and 134 Current Probe Amplifier provide versatility in a user-assembled ac current measurement system. Both probes provide accurate current measurements over a wide range of frequencies and are used with real-time oscilloscopes. Together with the 134 Amplifier or with passive termination, both of these probes can be used with scopes that have 1 MΩ or greater input impedance. Both the P6021 and P6022 avoid breaking a circuit by clipping on to a conductor. Just open the spring-loaded slide, place the conductor into the slot and release the slide. No electrical connection is required.

Shielded probe heads are not grounded when the slides are in their open positions, eliminating accidental grounding of the current under test.

P6021 Current Probe

For general purpose applications the P6021 Current Probe provides wide-band performance with excellent low-frequency characteristics. P6021 bandwidth is 120 Hz to 60 MHz. Passive termination is switchable from 2 mA/mV to 10 mA/mV.

P6022 Current Probe

The extra small size of the P6022 Current Probe makes it ideally suited to measure current in compact semiconductor circuits. P6022 bandwidth is 935 Hz to 200 MHz. Passive termination is switchable from 1 mA/mV to 10 mA/mV.

PERFORMANCE CHARACTERISTICS

	P6021 with Passive Termination		P6022 with Passive Termination		Probe with 134 Amplifier	
					P6021	P6022
Accuracy 3% Sensitivity	2 mA/mV	10 mA/mV	1 mA/mV	10 mA/mV	1 mA to 1 A/div @ 50 mV/div	
Bandwidth Low −3 dB High −3 dB	 450 Hz 60 MHz	 120 Hz 60 MHz	 8.5 kHz 130 MHz	 935 Hz 200 MHz	 12 Hz 38 MHz	 100 Hz 65 MHz
Risetime	5.8 ns	5.8 ns	2.7 ns	1.7 ns	9.2 ns	5.4 ns
Droop TC	0.35 ms	1.3 ms	18.7 μs	0.17 ms	13 ms	1.6 ms
Maximum Ac CW From To	15 A peak 1.2 kHz 5 MHz	15 A peak 300 Hz 5 MHz	6 A peak 10 kHz 10 MHz	6 A peak 3 kHz 10 MHz	15 A peak 230 Hz 5 MHz	6 A peak 1.3 kHz 10 MHz
Maximum Peak Current	250 A	250 A	100 A	100 A	250 A	100 A
Amp/Second Product	500×10^{-6}	500×10^{-6}	9×10^{-6}	9×10^{-6}	500×10^{-6}	9×10^{-6}
Maximum Dc	0.5 A	0.5 A	0.5 A	0.5 A	0.5 A	0.5 A
Insertion Z (Ω)	0.03 @ 1 MHz 1.0 @ 60 MHz		0.03 @ 1 MHz 0.2 @ 120 MHz		0.03 @ 1 MHz 1.0 @ 38 MHz	0.03 @ 1 MHz 0.2 @ 65 MHz
Propagation Delay (ns) 5 ft 9 ft	 9 15	 9 15	 9 15	 9 15	 9 15	 9 15
Maximum Voltage Barewire	 600 V	 600 V	 600 V	 600 V	 600 V	 600 V
Net Weight	≈1 lb		≈1 lb		≈5 lb	
Conductor Size	Up to 0.15 in dia		Up to 0.1 in dia		0.15 in dia	0.1 in dia
Operating Temperature	0°C to +50°C		0°C to +50°C		0°C to +50°C	

ORDERING INFORMATION

P6021

P6021 Current Probe, Term and 5 ft Cable
Order 015-0140-02 ..... **$345**

9 ft Cable and Term
Order 015-0140-03 ..... **$345**

5 ft Cable w/o Term
Order 010-0237-02 ..... **$290**

9 ft Cable w/o Term
Order 010-0244-02 ..... **$290**

P6022

P6022 Current Probe, Term, and 5 ft Cable
Order 015-0135-00 ..... **$380**

9 ft Cable and Term
Order 015-0135-01 ..... **$380**

5 ft Cable w/o Term
Order 010-0238-00 ..... **$295**

9 ft Cable w/o Term
Order 010-0238-02 ..... **$295**

134

134 Current Probe Amplifier
Order 015-0057-02 ..... **$625**

Option 04 — 230 V ac. Order 015-0057-03 ..... **$625**

OPTIONAL ACCESSORIES (for P6021, P6022, and 134)

Calibrator Adaptor — BNC. Order 013-0092-00 ..... **$35**

Carrying Case — For P6021 or P6022, and a 134 Amplifier. Order 016-0087-01 ..... **$25**

Passive Termination — For P6021. Order 011-0105-00 ..... **$116**

Passive Termination — For P6022. Order 011-0106-00 ..... **$126**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

CT-1/CT-2 Current Probes

The 1 GHz CT-1 is Used with 50 Ω Systems, or Wide Band Oscilloscopes, It has a Minimum Loading Effect on a 50 Ω Environment

The CT-2 is Used with Oscilloscopes Up To 100 MHz Bandwidth, It is Insulated for Limited Space Applications

The CT-1 and CT-2 Current Probes are designed for permanent or semi-permanent in-circuit installation. Each probe consists of a current transformer, an interconnecting cable and a termination. The current transformers are traversed by a small hole through which a current carrying conductor is passed during circuit assembly.

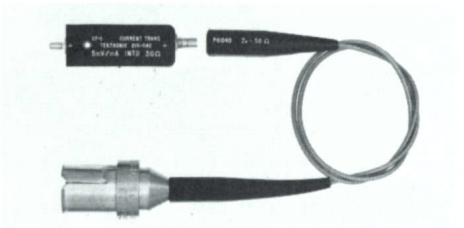
One probe cable can be used to monitor several current transformers that have been wired into a circuit.

CHARACTERISTICS

	CT-1	CT-2
Sensitivity	5 mV/mA	1 mV/mA
Accuracy	±3%	±3%
Risetime	350 ps	500 ps
Frequency Response		
Low: −3 dB	25 kHz	1.2 kHz
High: −3 dB	1 GHz	200 MHz
Decay Time Constant: L/R	6.35 μs	160 μs
Insertion Impedance:		
at 10 MHz	≈1 Ω	0.1 Ω
at 100 MHz	2 Ω	0.5 Ω
Capacitive Loading		
Barewire	1.5 pF for #14	1.8 pF for #16
Maximum Barewire Voltage	1000 V	1000 V
Dc Saturation Current:		
Current to Reduce L/R by X2	75 mA	175 mA
Pulse Current Rating*[1]	12 A	36 A
Not to Exceed:		
Amp S Product*[1]	1 x 10^{-6}	50 x 10^{-6}
Maximum CW Current*[1]	450 mA	2.5 A
Cable Length	18 inch	42 inch
Prop Delay	3.25 ns	6.1 ns
Cable Connector	GR874	BNC
Operating Temperature	−25°C to +65°C	

*[1] *With 50 Ω termination. Values are reduced by a factor of 2 if unterminated.*

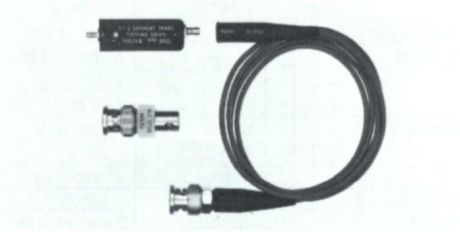
CT-1 with Probe Cable



The CT-1 Probe Cable (010-0133-00) provides the connection between the CT-1 current transformer and a GR scope input. This cable can also be used with other test point connectors such as Amphenol Series 27 Sub-Minax or Sealectro Sub-Miniature RF connectors.

Included Accessories — Instruction manual.

CT-2 with Probe Cable



The CT-2 Probe Cable (010-0164-00) is used to connect the CT-2 current transformer with a BNC oscilloscope input. A 50 Ω termination is used to terminate the cable at the high impedance input of an oscilloscope.

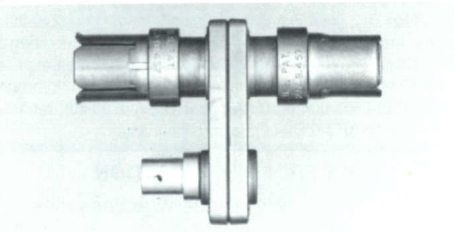
INCLUDED ACCESSORIES (CT-2)

50 Ω termination (BR, 011-0049-01); instruction manual.

ORDERING INFORMATION

CT-1 Current Transformer and Probe Cable.
Order 015-0041-00 ..... **$150**
CT-1 Current Transformer Only.
Order 015-0040-00 ..... **$90**
CT-2 Current Transformer, Probe Cable and Termination. **Order 015-0047-00** **$165**
CT-2 Current Transformer Only.
Order 015-0046-00 ..... **$100**

CT-3 Signal Pickoff

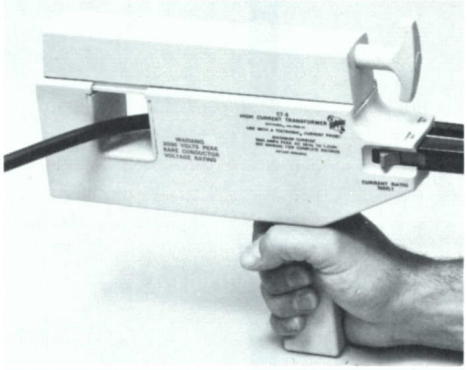


Designed for use with high-frequency oscilloscopes, the CT-3 Pickoff provides a convenient means of picking off a signal in a 50 Ω system. Used with any of the Tektronix sampling instruments, the CT-3 provides the link for use as a trigger source.

Sensitivity — 10% of the voltage under test, into a 50 Ω load.
Decay Time Constant — 4.5 μs at 0 dc current.
Risetime — <0.4 ns.
Frequency Response — 50 kHz to 875 MHz at 0 dc current.
Insertion Impedance — With 50 Ω termination is 1 Ω shunted by 4.5 μH, 2 Ω shunted by 4.5 μH without a 50 M termination.
Vswr — <1.2 at 1.5 GHz.
Voltage Rating — At 0 V dc is 25 V RMS, 1 kV pulse peak. The V's product is 100 V μs. If exceeded, the L/R decay will decay rapidly toward zero.

CT-3 Signal Pickoff. **Order 017-0061-00** **$143**

CT-5 Continuous Currents to 1000 A



1.5 Inch Diameter Conductors

Measurements on Bare Conductors to 3000 V

Nullifies Dc Effects to 300 A w/Dc Bucking Coil

Pulsed Currents to 50 kA

The CT-5 is a clip-on high-current transformer that extends the measurement capability of Tektronix clip-on current probes. Maximum low-frequency performance is obtained using the A6302/AM 503 Dc Current Probe. Pulse current to 50,000 amps may be measured using the P6021 and passive termination, provided the 0.5 A-s rating is not exceeded. The P6021 and 134 Current Probe Amplifier may also be used for measurements at normal line frequency and above. (The P6022 and CT-5 are not compatible with each other.) The CT-5 has receptacles for current probes in either 20:1 or 1000:1 step-down ratios. The 1.5 inch square opening makes it possible to clip onto large conductors without breaking the circuit under test. The core and shield assembly are insulated from the windings and the handle. This allows measurements on bare wires to 3000 V, and to 10 kV RMS with a high voltage bushing.

A dc bucking coil assembly allows up to 300 A of dc to be tolerated without appreciably degrading measurements. This is very useful for measuring ac signals on top of a dc voltage level.

CHARACTERISTICS (CT-5)

The following are characteristics of the CT-5 using either the A6302/AM 503 or P6021/134 combinations.

Risetime — 17.5 ns or less.
Insertion Impedance — ≤20 μΩ at 60 Hz; 20 mΩ at 1 MHz.
Current Range — 20 mA/div to 100 A/div with A6302/AM 503, and 20 mA/div to 20 A/div with P6021/134 (20:1 step down ratio); 1 A/div to 5 kA/div with A6302/AM 503, 1 A/div to 1 kA/div with P6021/134, (1000:1 step down ratio).
Accuracy — ±4%. Maximum Current is 1000 A peak cw.*[1]
Amp-S product — 8 A-s.
Maximum Voltage — Of circuit test is 3000 V (barewire).
Maximum Dc Bucking Current — 300 mA to buck out 300 A dc (using dc bucking coil).

*[1] *Maximum current 1000 A peak from 20 Hz to 1.2 kHz derating to 100 A peak at 1 MHz.*

CT-5 CURRENT MEASUREMENT COMBINATIONS

Product	Bandwidth	A-s Product	Maximum Current RMS	Maximum Current Peak Pulse
CT-5/A6302/AM 503	0.5 Hz to 20 MHz	0.1	700 A	50 kA
CT-5/P6021/134	12 Hz to 20 MHz	0.5	700 A	15 kA
CT-5/P6021/Term	120 Hz to 20 MHz	0.5	700 A	50 kA

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	57	2.3
Height	241	9.5
Depth	266	10.5
Weight	**kg**	**lb**
Net	1.8	4.0

INCLUDED ACCESSORIES

Carrying case (016-0191-03); 12 inch high voltage bushing (015-0194-00); instruction manual.

ORDERING INFORMATION

CT-3 Signal Pickoff. **Order 017-0061-00** **$143**
CT-5 Current Probe (Includes dc Bucking Coil).
Order 015-0189-01 ..... **$1,130**
Without dc Bucking Coil. **Order 015-0189-00** **$930**

OPTIONAL ACCESSORIES

Dc Bucking Coil. Order 015-0190-00 ..... **$290**
High-Voltage Bushing — 4 ft long, inside diameter 1 inch. Order 015-0194-01 ..... **$43**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

NEW

P6130 Dc to 250 MHz 10X with Readout

NEW P6131

Dc to 250 MHz 10X with Readout

Lightweight Tip

Flex Lightweight Cable

250 MHz Bandwidth

UL Listed

The P6130 and P6131 are the first of a new line of Tektronix subminiature probes. Both the P6130 and P6131 are 10X passive probes. Both probes have a spring-loaded coding pin on the BNC output connector which activates the volts/divsion readout-encoding circuit of the oscilloscope to include the 10X attenuation of the probe.

The P6130 general purpose probe accommodates scopes with bandwidths up to 250 MHz. Choose 1.5 meter, 2 meter, or 3 meter lengths. The P6131 is specifically designed to be used only with the Tektronix 2465/2445 and the 7A42. 1.3 meter and 3 meter lengths are available.

Both probes feature small size, a low-mass probe tip, and an extremely flexible probe cable. The unique reversible ground lead system provides versatile grounding methods. The hybrid probe tip circuitry provides a rugged lightweight tip, more uniform probe tip compensation for better high frequency response with reduced aberrations, and extremely good environmental characteristics. The modular construction of the probes allows easy repair without tools for lower cost of ownership.

A subminiature-to-miniature probe tip adaptor (013-0202-00) is also available. This adaptor allows the subminiature probe family to use the wide variety of probe accessories that Tektronix already provides for its miniature probe product line.

ELECTRICAL CHARACTERISTICS

	Probe Length	P6130	P6131
Attenuation		10X ±3%	10X ±1%
Loading	1.3 m	—	10.8 pF/10 MΩ
	1.5 m	12.7 pF/10 MΩ	—
	2.0 m	13.2 pF/10 MΩ	—
	3.0 m	14.5 pF/10 MΩ	14.5 pF/10 MΩ
Bandwidth	1.3 m	—	300 MHz
	1.5 m	250 MHz	—
	2.0 m	250 MHz	—
	3.0 m	150 MHz	150 MHz
DC Max		500 V	500 V
Scope Compatibility		May be used with Tektronix 2235, 2236, 464, 465, 466, 475, 485, and any 7000 Series 1 MΩ plug-in such as 7A15, 7A16, 7A18, and 7A26.	Designed to be used with the Tektronix 2465, 2445, and the 7A42.

CHARACTERISTICS

ENVIRONMENTAL

Temperature Range — Operating: −15°C to +75°C. Nonoperating: −62°C to +85°C.

Humidity — Five cycles (120 hr) 95% to 97% at +30°C to +60°C. MIL-E-16400F, Class 4.

Altitude — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

INCLUDED ACCESSORIES

Alligator ground lead (195-1870-01), microhook ground lead (195-4104-01); low inductance ground lead (195-4240-00); white marker band (334-2794-01; gray marker band (334-2794-03); red marker band (334-2794-06); green marker band (334-2794-07); probe connector (131-2766-03); probe holder (352-0687-00); protective pouch (016-0708-00); retractable hook tip (013-0208-00); instruction manual.

ORDERING INFORMATION

P6130 10X 1.5 Meter Probe w/Accessories
Order 010-6130-01 ..... $125

P6130 10X 2.0 Meter Probe w/Accessories
Order 010-6130-03 ..... $125

P6130 10X 3.0 Meter Probe w/Accessories
Order 010-6130-05 ..... $125

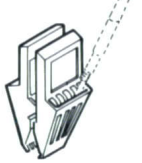
P6131 10X 1.3 Meter Probe w/Accessories
Order 010-6131-01 ..... $135

P6131 10X 3.0 Meter Probe w/Accessories
Order 010-6131-05 ..... $135

P6130 shown with 013-0202-00 adaptor in place.

OPTIONAL ACCESSORIES

PROBE-TO-DIP



PROBE-TO-BNC

PROBE-TO-GR

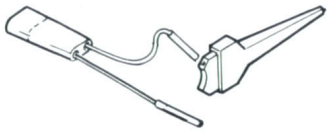
TEST POINT

SUBMINIATURE-TO-MINIATURE

MINIATURE PROBE ACCESSORIES

MINIATURE PROBE TIP TO DUAL LEAD ADAPTOR

MINIATURE RETRACTABLE HOOK TIP



PROBE-TO-GR

PROBE-TO-BNC

BAYONET

Probe to BNC Adaptor — Order 013-0195-00 ..... **$9.00**
50 Ω Probe to GR Adaptor — Order 017-0520-00 .... **$48.00**
100 ECB Test Points — Order 131-2766-01 ..... **$18.00**
100 Probe ECB Test Connectors
Order 136-0352-02 ..... **$19.25**
Subminiature-to-Miniature Adaptor
Order 013-0202-00 ..... **$3.00**

The following are used with the above subminiature-to-miniature adaptor.

Miniature-to-BNC Adaptor — Order 013-0084-01 ..... **$8.00**
Miniature Bayonet Tip Adaptor — Order 013-0085-00 . **$7.00**
50 Ω Miniature-to-GR Adaptor — Order 017-0088-00 . **$50.00**
Miniature-to-Squarepin Adaptor
Order 015-0325-00 ..... **$13.00**
Microcircuit Pincer Tip — Order 206-0222-00 ..... **$3.50**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

NEW

NEW P6121
Dc to 100 MHz 10X with Readout

NEW P6122
Dc to 100 MHz 10X with Readout

Lightweight Tip

Flex Lightweight Cable

100 MHz Bandwidth

UL Listed

The P6121 and P6122 probes are miniature, 10X passive probes and are fully compatible with the Tektronix family of miniature probe accessories. The P6121 is designed specifically for use with the Tektronix 2236 portable oscilloscope. The P6122 general purpose probe accommodates oscilloscopes with bandwidths up to 100 MHz. Both probes feature modular, easily replaceable parts, easy to use configuration, and hybrid circuitry. The hybrid probe tip circuitry proves more uniform probe tip compensation for better high frequency response with reduced aberration and also extremely good environmental characteristics (see Electrical Characteristics table).

CHARACTERISTICS

ENVIRONMENTAL

Temperature Range — Operating: −15°C to +75°C. Nonoperating: −62°C to +85°C.

Humidity — Five cycles (120 hr) 95% to 97% at +30°C to +60°C. MIL-E-16400F, class 4.

Altitude — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

ELECTRICAL CHARACTERISTICS

	Probe Length	P6121	P6122
Attenuation		10X ±0.2%	10X ±3%
Loading	1.5 m	11 pF/10 MΩ	14 pF/10 MΩ
Bandwidth	1.5 m	100 MHz	100 MHz
Dc Max		500 V	500 V
Scope Compatibility		Designed to be used only with the Tektronix 2236.	May be used with any Tektronix 100 MHz, 1 MΩ, 15 to 35 pF scope or plug-in*1.

*1 *Typical applications include the Tektronix T935A, T922R, T921, 2213, 2215, 2235, 2335, 2336, 2337, 5A38, 5A48, 7A15A, and the 7A18A.*

INCLUDED ACCESSORIES

Protective pouch (016-0708-00); retractable hook tip (013-0707-00); ground cover sleeve (166-0404-01); alligator ground lead (195-1870-00); IC test tip (015-0201-03); bayonet ground lead (195-6176-00); gray marker band (334-2794-02); instruction manual.

ORDERING INFORMATION

P6121 10X 1.5 Meter w/Accessories
Order 010-6121-01 ..... **$100**

P6122 10X 1.5 Meter w/Accessories
Order 010-6122-01 ..... **$77**

OPTIONAL ACCESSORIES

Electrical Lead — 23 AWG, 6.3 L.
Order 195-4104-00 ..... **$5.75**

Probe Tip with Actuator — Order 013-0191-00 ..... **$11.00**

IC Probe Tip — Package of 10.
Order 015-0201-04 ..... **$7.00**

IC Probe Tip — Package of 100.
Order 015-0201-05 ..... **$18.00**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

P6101 Dc to 34 MHz 1X

P6105 Dc to 100 MHz 10X with Readout
P6108 Dc to 100 MHz 10X

P6106 Dc to 250 MHz 10X with Readout

Simplified, Faster Maintenance and Repairs

High Fidelity Signal Acquisition at Low Cost

Rugged for Greater Reliability

Available in Three Lengths

Modular probes are an exciting new concept in probe design. The P6101, P6105, P6106, P6107, P6108, and P6149 Probes divide into three modules (probe heads, cables, and connector/compensation boxes). The modules snap together making maintenance and repair less expensive, faster, and much easier. Snap-on replacement modules eliminate soldering irons and tools, and modular probes do not have to be sent in to be repaired because spare modules can be ordered and stocked. Strain relief and modular component design make these probes rugged for greater reliability.

The P6101, P6105, P6106, and P6108 are available in three color-coded lengths—blue for one meter, yellow for two meters, and red for three meters. (The P6149 and P6107 are two meters long.) These probes may be used to acquire high fidelity signal from low source-impedance circuits.

Modular Probe Replacement Parts

Probe	Length	Probe Head		Probe Cable		Compensator/Connector	
P6101	1 Meter	206-0223-00	$20.00	175-1661-00	$27.00	103-0189-00	$18.50
	2 Meter	206-0223-00	$20.00	175-1661-01	$27.00	103-0189-00	$18.50
	3 Meter	206-0223-00	$20.00	175-1661-02	$27.00	103-0189-00	$18.50
P6105	1 Meter	206-0216-00	$48.00	175-1661-00	$27.00	206-0219-00	$48.00
	2 Meter	206-0217-00	$48.00	175-1661-01	$27.00	206-0220-00	$48.00
	3 Meter	206-0218-00	$48.00	175-1661-02	$27.00	206-0221-00	$48.00
P6106	1 Meter	206-0216-00	$48.00	175-1661-00	$27.00	206-0237-00	$65.00
	2 Meter	206-0217-00	$48.00	175-1661-01	$27.00	206-0238-00	$70.00
	3 Meter	206-0218-00	$48.00	175-1661-02	$27.00	206-0239-00	$70.00
P6107	2 Meter	206-0217-00	$48.00	175-1661-00	$27.00	206-0247-00	$42.00
P6108	1 Meter	206-0224-00	$41.00	175-1661-00	$27.00	206-0227-00	$43.00
	2 Meter	206-0225-00	$41.00	175-1661-01	$27.00	206-0228-00	$48.00
	3 Meter	206-0226-00	$41.00	175-1661-02	$27.00	206-0229-00	$48.00
P6149	2 Meter	206-0234-00	$38.00	175-1661-01	$27.00	206-0255-00	$32.00

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

P6107 Dc to 100 MHz 10X with Readout

P6149 Dc to 50 MHz 10X

Tektronix Modular Probes are designed for specific Tektronix Instruments, but may be purchased as options for all Tektronix oscilloscopes with 1 MΩ and appropriate pF inputs as indicated in the chart.

With oscilloscopes that are equipped with vertical scale or CRT readout, the P6105 and P6106 will automatically scale the readout by a factor of 10. This makes mental calculations unnecessary. Also ground level can be determined on the display by actuating a button on the probe head, without having to return to the oscilloscope.

The P6149 and P6107 feature a right angle BNC connector. This can be useful when bench space is limited.

CHARACTERISTICS

Type	Attenuation	Length	Package Number	Loading		Useful BW MHz	Dc Maximum	Scope in pF	Readout
P6101	1X	1 m 2 m 3 m	010-6101-01 010-6101-03 010-6101-05	1 MΩ	32 pF 54 pF 78 pF	34 15.5 8	500 V*1	ANY	—
P6105	10X	1 m 2 m 3 m	010-6105-01 010-6105-03 010-6105-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	100 100 95	500 V*3	15 to 47	YES
P6106	10X	1 m 2 m 3 m	010-6106-01 010-6106-03 010-6106-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	250 250 150	500 V*4	15 to 24	YES
P6107	10X	2 m	010-6107-03	10 MΩ	13.0 pF	100	500 V*3	14 to 47	YES
P6108	10X	1 m 2 m 3 m	010-6108-01 010-6108-03 010-6108-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	100 100 95	500 V*3	15 to 47	NO
P6149	10X	2 m	010-6149-03	10 MΩ	15.5 pF	50	500 V*3	20 to 62	NO

*1 Maximum Input Voltage is 500 V dc + peak ac to 300 kHz derated to 20 V at 30 MHz.
*2 Maximum Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 27 V at 10 MHz.
*3 Maximum Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 30 V at 50 MHz.
*4 Maximum Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 70 V at 100 MHz.

Included Accessories with double alpha codes are pictured on pages 456 and 457.

Modular Parts Snap Together

INCLUDED ACCESSORIES

Retractable hook tip (BB, 013-0107-03); insulating sleeve (BP, 166-0404-01); two probe tips, available in packages of 10 only (BO, 206-0191-03); probe holder (352-0351-00); 75 mm ground lead for P6106 only (DD, 175-0263-01); 130 mm ground lead for P6101, P6105, P6108 and P6149 only (DD, 175-0124-01) 300 mm ground lead (DD, 175-0125-01); 3 pair, black, white and silver gray marker bands for all probes except P6149, available in packages of 9 sets of different colors (016-0633-00); 2 pair, gray and silver gray marker bands for P6149, available in packages of 9 sets of different color (016-0633-00); 2 miniature alligator clips (AS, 344-0046-00); accessory pouch (016-0521-00); instruction manual.

ORDERING INFORMATION

P6101 1X Probe, 2 m Cable
Order 010-6101-03 ..... **$67**
Option 01 — 1 m cable. Order 010-6101-01 ..... **$67**
Option 02 — 3 m cable. Order 010-6101-05 ..... **$67**

P6105 10X Probe, 2 m Cable
Order 010-6105-03 ..... **$110**
Option 01 — 1 m cable. Order 010-6105-01 ..... **$110**
Option 02 — 3 m cable. Order 010-6105-05 ..... **$110**

P6106 10X Probe, 2 m Cable
Order 010-6106-03 ..... **$135**
Option 01 — 1 m cable. Order 010-6106-01 ..... **$135**
Option 02 — 3 m cable. Order 010-6106-05 ..... **$135**

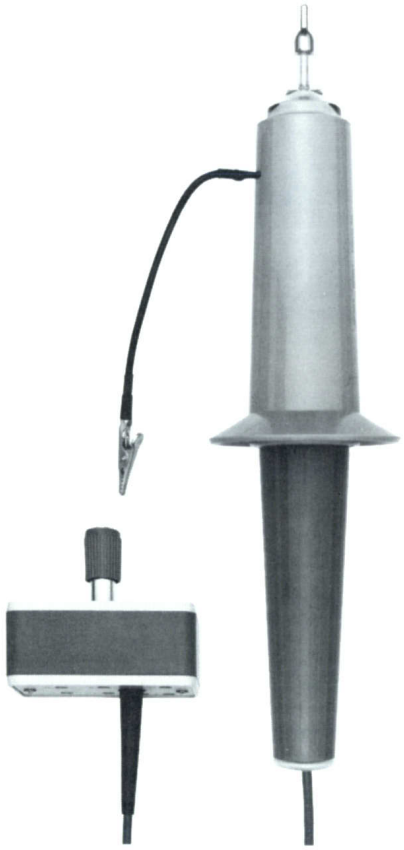
P6107 10X Probe, 2 m Cable
Order 010-6107-03 ..... **$117**

P6108 10X Probe, 2 m Cable
Order 010-6108-03 ..... **$100**
Option 01 — 1 m cable. Order 010-6108-01 ..... **$100**
Option 02 — 3 m cable. Order 010-6108-05 ..... **$100**

P6149 10X Probe, 2 m cable
Order 010-6149-03 ..... **$110**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

P6015 40 kV 1000X



Measure up to 40 kV Peak Pulse

High Voltage Probe

Up to 20 kV Dc + Peak Ac

75 MHz Useful Bandwidth

For 1 MΩ Inputs

The P6015 Provides 1000X attenuation for oscilloscope measurements up to 40 kV peak. Voltage or duty cycle derating is necessary for RF voltages at frequencies over 100 kHz, or in temperatures above 25°C.

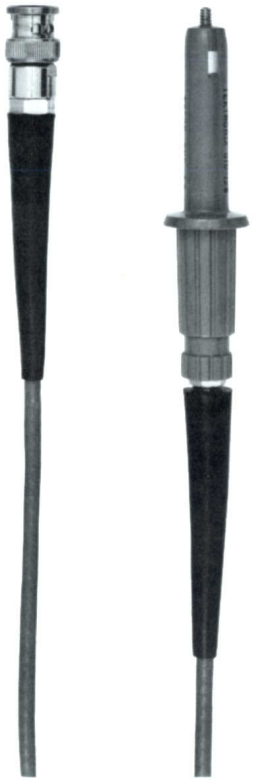
The probe can be compensated for instruments with nominal input capacitance of 12 pF to 47 pF.

INCLUDED ACCESSORIES

BNC compensating box (015-0049-00); high-voltage dielectric fluid can (AU, 252-0120-00); alligator clip (AQ, 344-0005-00); carrying case (016-0128-02); probe holder (352-0056-00); instruction manual.

P6015 1000X Probe, 10 ft Cable
Order 010-0172-00 ..... **$645**

P6007 Dc to 25 MHz 100X



1500 V Dc

Low Capacitance Loading

The P6007 is a low input capacitance, high-voltage (1.5 kV) probe. It can be compensated to match all Tektronix plug-ins and oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ.

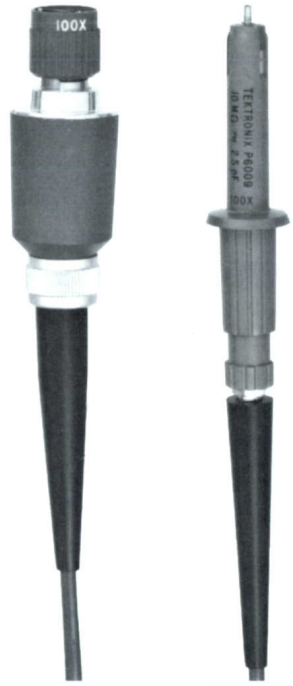
INCLUDED ACCESSORIES

Banana tip (AK, 134-0013-00); 0.055 inch diameter straight tip (AA, 206-0015-00); retractable hook tip (AN, 013-0071-00); 13 cm (5 inch) ground lead (175-0124-01); 30 cm (12 inch) ground lead (175-0125-01); hook tip (AG, 206-0105-00); probe holder (352-0090-00); two alligator clips (AS, 344-0046-00); instruction manual.

ORDERING INFORMATION

P6007 100X Probe
6 ft Cable. Order 010-0165-00 ..... **$110**
3.5 ft Cable. Order 010-0150-00 ..... **$110**
9 ft Cable. Order 010-0152-00 ..... **$110**
12 ft Cable. Order 010-0154-00 ..... **$110**

P6009 Dc to 120 MHz 100X



1500 V Dc

Dc to 120 MHz

Low Capacitance—2.5 pF

The P6009 is a low input capacitance, high-voltage (1.5 kV) probe designed for use with Tektronix dc to 150 MHz oscilloscopes. The probe can be compensated to match Tektronix plug-ins and oscilloscopes with nominal input capacitances of 12 pF to 47 pF and input resistance of 1 MΩ.

A version of the P6009 is equipped with a special BNC connector that provides CRT Readout information when used with plug-in units and mainframes that have these features.

INCLUDED ACCESSORIES

30 cm (12 inch) ground lead (175-0125-01); 13 cm (5 inch) ground lead (175-0124-01); 7.5 cm (3 inch) ground lead (DD,175-0263-01); probe holder (352-0090-00); 0.080 inch diameter spring tip (AB, 206-0060-00); two alligator clips (AS, 344-0046-00); banana tip (AK, 134-0013-00); 0.055 inch diameter straight tip (AA, 206-0015-00); retractable hook tip (AN, 013-0071-00); hook tip (AG, 206-0105-00); bayonet ground assembly (AJ, 013-0052-00); instruction manual.

ORDERING INFORMATION

P6009 100X Probe, 9 ft Cable
W/Readout. Order 010-0264-01 ..... **$175**
W/O Readout. Order 010-0170-00 ..... **$175**

CHARACTERISTICS

	Attenuation	Accuracy	Input Resistance	Input Capacitance			Probe Risetime	Aberrations	Bandwidth	Nominal Cable Length (ft)	Maximum Dc Voltage	Derated Above	Derated to @ Frequency	Compensation Range (pF)
				3½ ft	6 ft	9 ft								
P6007	100X	3%	10 MΩ	2 pF	2.2 pF	2.4 pF	14.0 ns	±3	25 MHz	3½, 6, 9, 12	1.5 kV	200 kHz	2 kV @ 5 MHz	15 to 55
P6009	100X	3%	10 MΩ		2.5 pF		2.9 ns	±3	120 MHz	9	1.5 kV	200 kHz	450 V @ 40 MHz	15 to 47
P6015	1000X	Adjustable	100 MΩ	3 pF (10 ft only)			4.0 ns	±5	250 MHz	10	20.0 kV	100 kHz	2 kV @ 20 MHz	12 to 47

Included Accessories with double alpha codes are pictured on pages 456 and 457.

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

P6062B Dc to 100 MHz with Readout
P6063B Dc to 200 MHz with Readout

1X to 10X Selectable Attenuation

Switch on Probe Body

The P6062B and P6063B are passive dual attenuation probes designed for Tektronix oscilloscopes with bandwidths to 100 and 200 MHz. A sliding switch on the probe body selects 1X or 10X attenuation. The probe provides readout coding and a pushbutton for actuating a ground reference in the 1X or 10X position. The ground reference can be used as a means of trace identification for a multitrace display. The 1X position of the probe allows the use of the full instrument sensitivity. This is valuable when evaluating small signals of 10 MHz or less. The 1X-10X switch allows the user to switch in and out a decade of sensitivity without returning to the oscilloscope. The user may also arbitrarily switch from 1X to 10X in order to evaluate the effects of loading by the oscilloscope.

The P6063B is a fast-rise dual attenuation, passive probe designed for Tektronix oscilloscopes with bandwidths greater than 100 MHz.

COMMON CHARACTERISTICS

	Nominal Probe Length	P6062B		P6063B	
Attenuation		1X	10X	1X	10X
Accuracy		Same as Scope	3%*1	Same as Scope	3%*1
Input Resistance		Same as Scope	10 MΩ*1	Same as Scope	10 MΩ*1
Input Capacitance	3½ ft 6 ft 9 ft	100 pF 105 pF 135 pF	13.5 pF 14 pF 17 pF	80 pF 105 pF NA	11 pF 14 pF NA
Bandwidth	3½ ft 6 ft 9 ft	8 MHz 6.7 MHz 4.5 MHz	100 MHz 100 MHz 100 MHz	12 MHz 6 MHz NA	200 MHz 200 MHz NA
Maximum Voltage		100 V peak	500 V peak	100 V	500 V
Derated Above		450 kHz	3.5 MHz	450 kHz	4.5 MHz
Derated to Frequency		35 V @ 10 MHz	35 V @ 50 MHz	35 V @ 10 MHz	30 V @ 50 MHz
Aberrations		±3%	<5% p-p	±3%	<5% p-p
Risetime			3.5 ns		1.7 ns
Compensation Range		15 pF to 47 pF		15 pF to 24 pF	

*1 *In 10X position the input R = 10 MΩ ±0.5% with an oscilloscope input R = 1 MΩ ±2%.*

P6053B 10X with Readout

Miniature

Fast Risetime

The P6053B is a minature fast-rise 10X probe designed for Tektronix instruments having a nominal input capacitance of 15 pF to 24 pF. The probe has a pushbutton for actuating the trace-identify function of the oscilloscope mainframe and readout capability.

CHARACTERISTICS

Attenuation — 10X. **Input Resistance** — 10 MΩ. **Input Capacitance** — 9.5 pF with 3.5 ft probe. 12.5 pF with 6 ft version, 13.5 pF with 9 ft version. **Bandwidth (with 225 MHz or Greater Oscilloscope)** — ≈200 MHz for 3.5 and 6 ft versions, ≈115 MHz for the 9 ft version. **Voltage Rating** — 500 V (dc + peak ac). Peak voltage derating is necessary for cw frequencies higher than 5 MHz. At 10 MHz, the maximum allowable peak voltage is 275 V; 23 V at 100 MHz; 18 V at 150 MHz.

INCLUDED ACCESSORIES

Probe holder (352-0351-00); electrical insulating sleeve (BP, 166-0404-01); retractable hook tip (BB, 013-0107-03); probe tip hook (BU, 206-0114-00); accessory pouch (016-0521-00); 13 cm (5 inch) ground lead (175-0124-01); 30 cm (12 inch) ground lead (DD, 175-0125-01); two alligator clips (AS, 344-0046-00). For P6053B only, bayonet ground assembly (BM, 013-0085-00); 7.5 cm (3 inch) ground lead (DD, 175-0263-01); instruction manual.

ORDERING INFORMATION

P6062B Switchable Attenuation Probe
6 ft Cable. Order 010-6062-13 ..... **$175**
3.5 ft Cable. Order 010-6062-11 ..... **$175**
9 ft Cable. Order 010-6062-15 ..... **$175**

P6063B Switchable Attenuation Probe
6 ft Cable. Order 010-6063-13 ..... **$210**
3.5 ft Cable. Order 010-6063-11 ..... **$210**

P6053B Miniature 10X Probe
6 ft Cable. Order 010-6053-13 ..... **$165**
3.5 ft Cable. Order 010-6053-11 ..... **$165**
9 ft Cable. Order 010-6053-15 ..... **$165**

P6055 20,000:1 CMRR 10X with Readout

High CMRR

Compact Size

Low Capacitance

Dc to 60 MHz

The P6055 is a miniature, low-capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to 10X to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ± 2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes allows the user to adjust the attenuation of the probes for compatibility with the various Tektronix plug-ins.

CHARACTERISTICS

CMRR — 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz. **Attenuation** — Adjustable to 10X. **Input Resistance** — 1 MΩ ±0.5%. **Input Capacitance** — ≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance. **Maximum Useful Bandwidth** — 60 MHz. **Typical Probe Risetime** — 5.8 ns. **Maximum Voltage** — 500 V (dc + peak ac) from dc to 12 MHz. P-p voltage derates to 100 V at 70 MHz.

INCLUDED ACCESSORIES

Retractable hook tip (BB, 013-0107-03); 13 cm (5 inch) ground lead (175-0124-01); probe holder (352-0090-00); two electrical insulating sleeves (BP, 166-0404-01); two alligator clips (AS, 344-0046-00); adjustable tool (CP, 003-0675-01); hook tip (BU, 206-0114-00); 13 cm (6 inch) electrical ground lead (DF, 175-1256-00); 30 cm (12 inch) ground lead (175-0125-01); instruction manual.

ORDERING INFORMATION

P6055 10X Differential Probe, 3.5 ft Cable
Order 010-6055-01 ..... **$260**

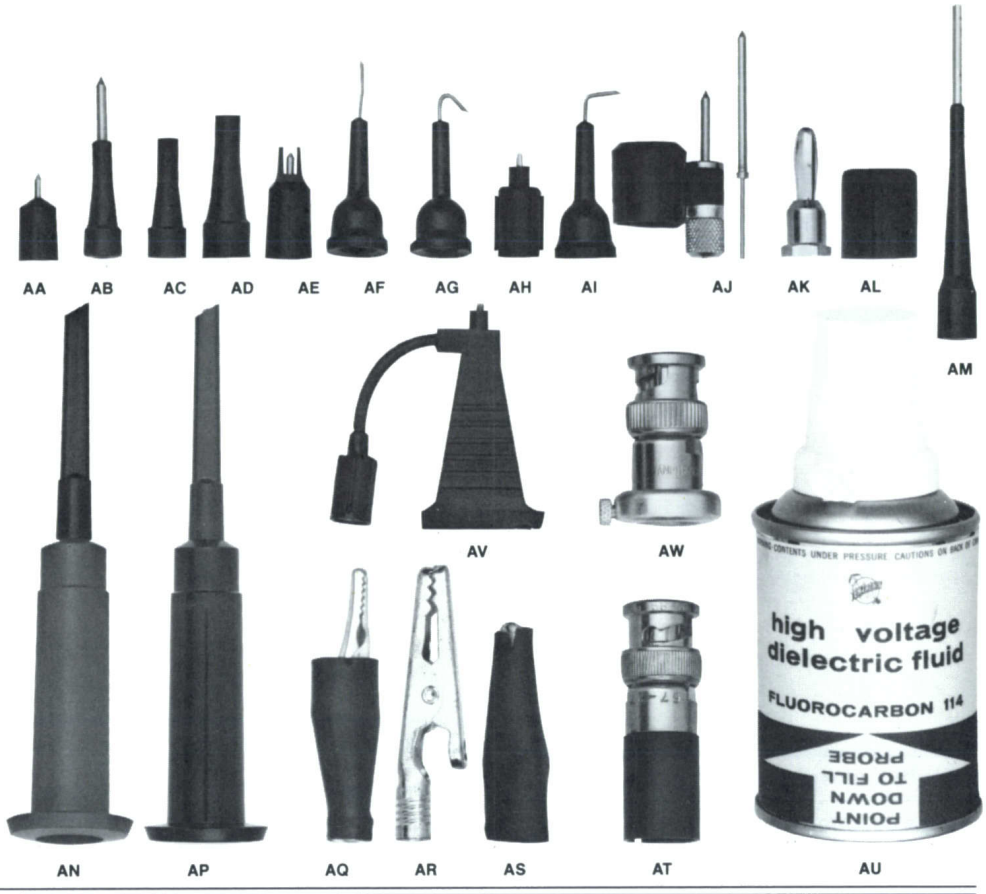
Matched Pair of P6055
Order 015-0437-00 ..... **$440**

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

#6-32 Probe Tips and Accessories

The following tips and adaptors can be used on all Tektronix Probes that accept a #6-32 screw-on tip, including the P6006, P6007, P6008, P6009, P6028, and P6060 Probes and others with 6-32 adaptor.

CODE	DESCRIPTION	PART NUMBER	PRICE
AA	Probe straight tip (0.055 in dia)	206-0015-00	$ 1.00
AB	Probe spring tip (0.080 in dia)	206-0060-00	$ 2.00
AC	Probe spring tip (accepts 0.065 in dia pin)	206-0061-00	$ 1.50
AD	Probe spring tip (accepts 0.068 in dia pin)	206-0168-00	$ 2.50
AE	IC test tip	206-0203-00	$ 1.50
AF	Probe long straight tip (0.032 in dia)	206-0104-00	$ 1.50
AG	Probe hook tip	206-0105-00	$ 1.50
AH	Probe ground lead adaptor (#6-32 to 0.025 in square pin closing	206-0137-01	$ 2.00
AI	Probe right angle hook tip	206-0185-00	$ 1.50
AJ	Bayonet ground assembly	013-0052-00	$ 8.00
AK	Probe banana tip	134-0013-00	$ 1.00
AL	Probe ground cover (for P6009)	166-0428-00	$ 1.35
AM	Probe calibration tip (0.063 in dia)	206-0100-00	$10.50
AN	Probe retractable hook tip	013-0071-00	$ 3.50
AP	Probe retractable hook tip (for P6008E)	013-0071-01	$ 3.00
AQ	Alligator clip	344-0005-00	$ 4.00
AR	Alligator clip	344-0045-00	$ 1.40
AS	Minature alligator clip	344-0046-00	$ 1.40
AT	Probe tip to BNC adaptor	013-0054-00	$18.00
AU	High-voltage dielectric fluid 3 oz	252-0120-00	$ 5.00
AV	Probe pin tip (accepts 0.025 in IBM SLT in)	206-0134-03	$ 4.50
AW	Probe tip to BNC adaptor (for P6028)	013-0056-00	$18.00



Modular Probe Replacement Parts

Probe	Length	Probe Head		Probe Cable		Compensator/Connector	
P6101	1 Meter	206-0223-00	$20.00	175-1661-00	$27.00	103-0189-00	$18.50
	2 Meter	206-0223-00	$20.00	175-1661-01	$27.00	103-0189-00	$18.50
	3 Meter	206-0223-00	$20.00	175-1661-02	$27.00	103-0189-00	$18.50
P6105*1	1 Meter	206-0216-00	$48.00	175-1661-00	$27.00	206-0219-00	$48.00
	2 Meter	206-0217-00	$48.00	175-1661-01	$27.00	206-0220-00	$48.00
	3 Meter	206-0218-00	$48.00	175-1661-02	$27.00	206-0221-00	$48.00
P6106*1	1 Meter	206-0216-00	$48.00	175-1661-00	$27.00	206-0237-00	$65.00
	2 Meter	206-0217-00	$48.00	175-1661-01	$27.00	206-0238-00	$70.00
	3 Meter	206-0218-00	$48.00	175-1661-02	$27.00	206-0239-00	$70.00
P6107	2 Meter	206-0217-00	$48.00	175-1661-00	$27.00	206-0247-00	$42.00
P6108	1 Meter	206-0224-00	$41.00	175-1661-00	$27.00	206-0227-00	$43.00
	2 Meter	206-0225-00	$41.00	175-1661-01	$27.00	206-0228-00	$48.00
	3 Meter	206-0226-00	$41.00	175-1661-02	$27.00	206-0229-00	$48.00
P6149	2 Meter	206-0234-00	$38.00	175-1661-01	$27.00	206-0255-00	$32.00

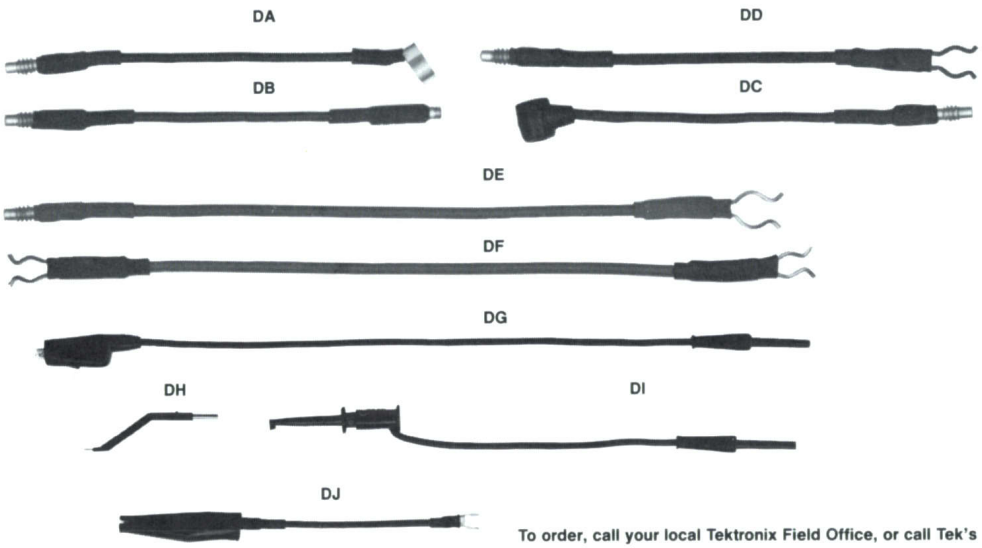
*1 The BNC Connector with readout may be replaced with 131-1799-01

CODE	DESCRIPTION	LENGTH (in)	PART NUMBER	PRICE
DA	Ground lead for S-3A, P6056, P6057	3	175-0249-00	$5.00
DB	Ground leads for P6054, P6075	3	175-0848-00	$2.00
	7A11, and P6201	5	175-0848-01	$1.75
		12	175-0848-02	$1.75
DC	Ground leads for P6202 and P6420	3	175-0849-00	$6.00
		6	175-0849-01	$6.00
DD	Ground lead*1	3	175-0263-01	$2.50
	Ground lead*1	5	175-0124-01	$2.50
	Ground lead*1	12	175-0125-01	$2.50
DE	Ground leads for S-3A, P6202, P6420	6	175-1017-00	$3.50
DF	Ground lead for P6055	6	175-1256-00	$5.00
DG	Alligator clip for P6230, P6120, P6130 families		195-1870-00	$5.00
DH	Subminiature Low Impedance for P6230, P6130 families		195-4240-00	$2.40
DI	Microhook for P6230, P6120, P6130 families		195-4104-00	$5.75
DJ	Minature S-3A to alligator clip		195-6176-00	$5.00

*1 For the P6053B, P6054A, P6075A, P6101, P6105, P6106, P6108, P6149, and other probes requiring clip-on ground leads.

CABLE MARKER SETS (Not Pictured)

DESCRIPTION	PART NUMBER	PRICE
For 1/8 in dia cable	016-0130-00	$7.00
For 3/16 in dia cable	016-0127-00	$6.00
For all modular cables	016-0633-00	$4.00



To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

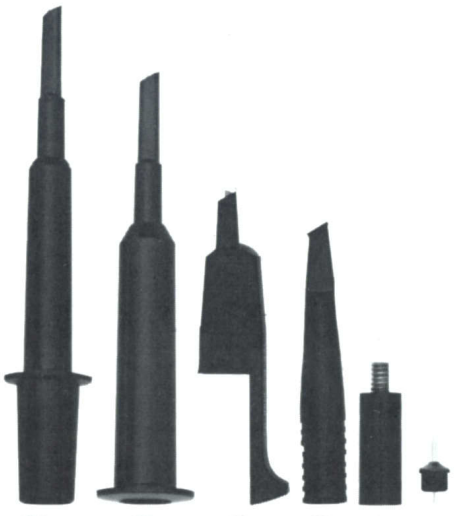
Minimum acceptable order is $25.00.

MODULAR/MINIATURE ADAPTORS

CODE	DESCRIPTION	PART NUMBER	PRICE
BA	Retractable hook tip (for all miniature probes)	013-0105-00	$7.00
BB	Retractable hook tip (for P6053B, P6055, P6062B, P6063B, P6101, P6105, P6106, P6108, and P6149)	013-0107-03	$3.25
	Retractable hook tip (for P6120, P6121, and P6122)	013-0107-04	$2.20
BC	Probe tip, IC Grabber	013-0191-00	$11.00
BD	Miniature retractable hook tip	206-0222-00	$3.50
BE	Probe tip flexible, adapts miniature probe to retractable hook tip (BD)	103-0177-01	$6.50
BF	Probe tip flexible for 0.025 square pin	206-0193-00	$8.00
BG	Miniature probe to #6-32 adaptor (for all miniature probes except P6045 and P6202)	103-0051-01	$4.00
BH	Miniature probe to #6-32 adaptor with ground connection	103-0131-00	$5.50
BI	Probe pin tip (accepts 0.025 in IBM SLT pin)	206-0209-00	$3.50
BJ	Miniature probe tip to GR adaptor	017-0076-00	$42.00
BK	Miniature probe tip to GR 50 Ω termination adaptor	017-0088-00	$50.00
	Subminiature probe tip to GR 50 Ω termination adaptor	017-0520-00	$48.00
BL	Chassis mount test jack (for miniature probes)	131-0258-00	$4.50
BM	Bayonet ground assembly	013-0085-00	$7.00
BN	Miniature probe tip cover, IC tester, Package of 10	015-0201-04	$7.00
	Package of 100	015-0201-05	$18.00
BO	Replaceable probe tip, pkg of 10. All miniature probes except P6202 and P6420	206-0191-03	$17.00
BP	Miniature probe tip ground cover, insulating sleeve	166-0404-01	$1.00
BQ	Electrical contact	214-0283-00	$1.00
BR	Termination, 50 Ω	011-0049-01	$25.00
BS	Miniature probe tip to BNC adaptor	013-0084-01	$8.00
	Subminiature probe tip to BNC adaptor	013-0195-00	$9.00
BT	Miniature probe tip to BNC adaptor for all except P6202	013-0084-02	$10.00
BU	Miniature probe tip hook	206-0114-00	$3.00
BV	Miniature probe tip straight	206-0114-01	$3.00
BW	Miniature probe tip to dual lead adaptor	015-0325-00	$13.00
BX	Subminiature retractable hook tip	013-0208-00	$1.50
BY	Subminiature to miniature probe tip adaptor (allows use of minature accessories with subminiature probes)	013-0202-00	$3.00

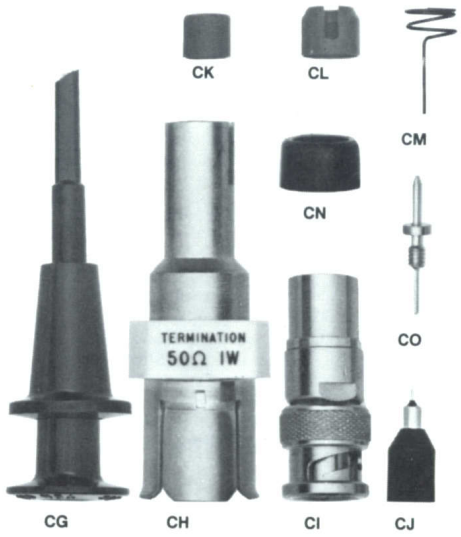
OTHER ADAPTORS

The following tips and adaptors are designed for use with Tektronix Miniature Probes and accept a slip-on tip.



CODE	DESCRIPTION	PART NUMBER	PRICE
CA	Retractable hook tip (for P6010 and P6048)	013-0090-00	$4.00
CB	Retractable hook tip (for S-3A, P6202, and P6420)	013-0097-01	$7.00
CC	Retractable hook tip (for 7A11 and P6401)	013-0106-00	$9.25
CD	Retractable hook tip (for 211, 212, 213, 214, 221)	013-0107-02	$3.25
CE	Miniature probe to #6-32 adaptor (for P6045, P6046, P6202, 7A11, S-3A)	103-0051-00	$4.00
CF	Replaceable probe tip for P6202 and P6420, pkg of 10	206-0230-03	$17.00

P6201 ACCESSORIES



CODE	DESCRIPTION	PART NUMBER	PRICE
CG	Retractable probe tip (for P6201 only)	013-0135-00	$4.25
CH	P6201 probe tip to GR 50 Ω termination adaptor	017-0094-00	$55.00
CI	Probe tip to BNC adaptor (for P6201 only)	013-0145-00	$15.00
CJ	Probe tip to test point jack (for P6201 only)	103-0164-00	$6.00
CK	Insulating sleeve, electrical (for P6201 only)	166-0557-00	$1.00
CL	Ground contact insulator (for P6201 only)	342-0180-00	$1.00
CM	Ground contact (for P6201 only)	131-1302-00	$1.50
CN	Ground lead, insulating sleeve (for P6201 only)	166-0433-00	$1.00
CO	Replaceable probe tip (for P6201 only)	206-0200-00	$1.00

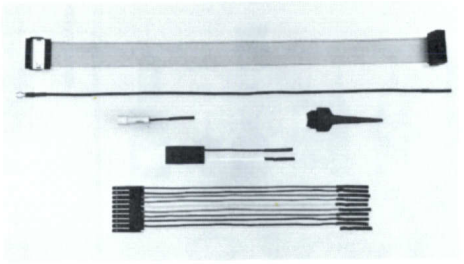
PROBE TOOLS

CODE	DESCRIPTION	PART NUMBER	PRICE
CP	Adjustment tool, probe	003-0675-01	$2.35
CQ	Probe tip extractor	003-0825-00	$2.10

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

Minimum acceptable order is $25.00.

LOGIC PROBE TEST LEADS



16 pin low profile dip clip (can be used with 14 or 16 pin ICs)	015-0330-00	$35.00
10 wide comb set with grabber tips not included	012-0747-00	$50.00
Miniature retractable hook tip	206-0222-00	$3.50
Dual lead adaptor for miniature probes	015-0325-00	$13.00
Flexible probe tip, P6006 type	103-0210-00	$5.75
Ground lead, P6006 type	195-0234-00	$4.50

PATCH CORDS

BNC to BNC, 18 in		
Red	012-0087-00	$6.50
Black	012-0086-00	$6.50
BNC to banana plug-jack, 18 in		
Red	012-0091-00	$6.50
Black	012-0090-00	$7.00
Banana plug-jack to banana plug-jack, 18 in		
Red	012-0031-00	$6.50
Black	012-0039-00	$7.00

Pin-jack to pin-jack, 0.08 in dia pin		
Red, 8 in	012-0179-00	$3.75
Red, 18 in	012-0180-00	$3.75
Black, 8 in	012-0181-00	$3.75
Black, 18 in	012-0182-00	$6.00

TEST LEADS

Test Lead, Black, 4 ft	012-0425-00	$12.00
Test Lead, Red, 4 ft	012-0426-00	$17.50
Test Lead, Black, 4 ft	012-0426-01	$17.50
Test Lead set includes 012-0425-00, 012-0426-00,and 013-0107-03	012-0427-00	$29.00

PERSONALITY MODULE TEST LEADS

40 Pin Dip Clip—10 cm cable (order M/F adaptor below)	015-0339-00	$44.00
40 Pin Dip Clip—30 cm cable Male Adaptor for 40 Pin (order M/F adaptor below)	015-0339-02	$44.00
Low Profile Dip Clip—for use with PM 101/7D02 General Purpose Personality Module (or with individual leads such as the 10-wide comb set 012-0747-00)	380-0560-05	$15.00
Female Adaptor for 40 Pin Low Profile Dip Clip—for use with dedicated 7D02 personality modules	380-0647-01	$30.00

COAXIAL CABLES

BNC Connectors

Coaxial, 50 Ω, 42 in	012-0057-01	$17.00
Coaxial, 75 Ω, 42 in	012-0074-00	$17.00
Coaxial, 93 Ω, 42 in	012-0075-00	$25.00
Coaxial, 50 Ω, 18 in	012-0076-00	$17.00
Coaxial, 50 Ω, 18 in, Male to Female	012-0104-00	$25.00
Coaxial, 50 Ω ±1% Precision, 36 in	012-0482-00	$25.00

N Connectors 50 Ω

Coaxial N connectors, 6 ft	012-0114-00	$25.00

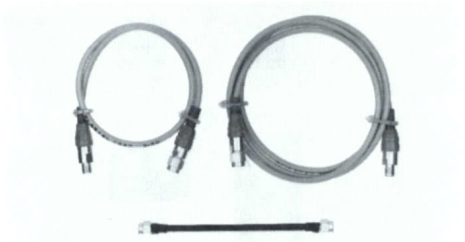
GR Connectors 50 Ω

Coaxial 10 ns RG58A/U	017-0501-00	$85.00
Coaxial 5 ns RG213/U	017-0502-00	$160.00
Coaxial 1 ns RG58A/U*[1]	017-0503-00	$100.00
Coaxial 20 ns RG213/U	017-0504-00	$100.00
Coaxial 2 ns RG58A/U	017-0505-00	$120.00
Coaxial 5 ns RG58A/U	017-0512-00	$90.00
Coaxial 10 in RG213/U	017-0513-00	$75.00
Coaxial 20 in RG213/U	017-0515-00	$90.00

[1] Connector on one end only.

50 Ω CABLES

SMA (3 mm) Connectors 50 Ω



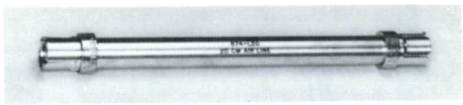
Coaxial 2 ns	015-1005-00	$80.00
Coaxial 5 ns	015-1006-00	$130.00
Coaxial semirigid 500 ps	015-1015-00	$40.00
Coaxial semirigid 750 ps	015-1017-00	$35.00
Coaxial 1 ns	015-1019-00	$105.00

BNC to BSM Connectors 50 Ω

Coaxial, 10 in, RG58 BSM Female to BNC Male	012-0128-00	$20.00
Coaxial, 18 in, RG58 BSM Female to BNC Male	012-0127-00	$20.00

Minimum acceptable order is $25.00.

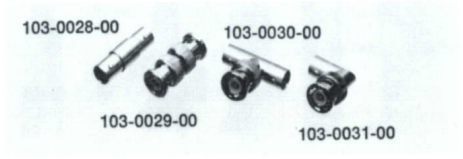
50 Ω AIR LINE



The 20 cm 50 Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω ±0.4%. Time delay is 0.6698 ns ±0.4%.

50 Ω Air Line	017-0084-00	$165.00

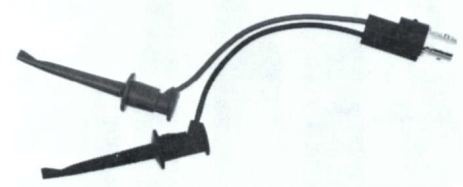
ADAPTORS



BNC Female to BNC Female	103-0028-00	$5.00
BNC Male to BNC Male	103-0029-00	$5.50
BNC T	103-0030-00	$6.50
BNC Elbow Male to Female	103-0031-00	$11.25

BNC Male to GR	017-0064-00	$75.00
BNC Male to UHF Female	103-0032-00	$4.75
BNC Male to Binding Post	103-0033-00	$4.75
BNC Male to Dual Binding Post	103-0035-00	$12.00
BNC Male to N Female	103-0058-00	$7.00

BNC Female to clip leads	013-0076-00	$21.00
BNC Female to GR	017-0063-00	$43.00
BNC Female to uhf Male	103-0015-00	$4.50
BNC Female to BSM Male	103-0036-00	$15.00
BNC Female to N Male	103-0045-00	$6.50
BNC Female to Dual Banana	103-0090-00	$7.50

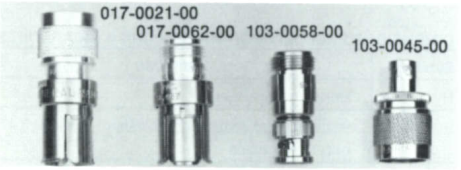


BNC Female to EZ Ball	013-0076-01	$17.50

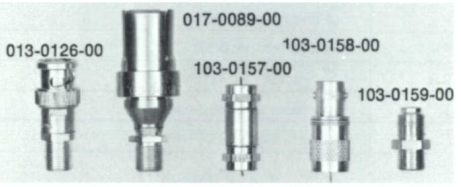
GR to N Male	017-0021-00	$35.00
GR to C Male	017-0027-00	$55.00
GR to N Female	017-0062-00	$50.00
GR to C Female	017-0065-00	$80.00

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

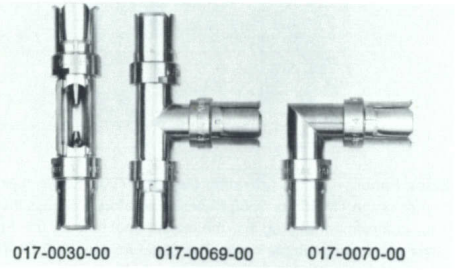
GR to BNC Female	017-0063-00	$43.00
GR to BNC Male	017-0064-00	$75.00
50 Ω termination, thru-line (GR to BNC Male)	017-0083-00	$90.00



N Male to GR	017-0021-00	$35.00
N Female to GR	017-0062-00	$50.00
N Male to BNC Female	103-0045-00	$6.50
N Female to BNC Male	103-0058-00	$7.00

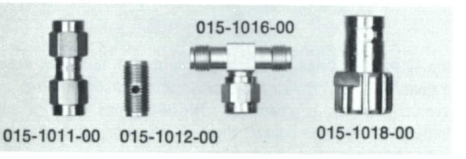


"F" Female to BNC Male	013-0126-00	$16.00
"F" Female to GR874	017-0089-00	$45.00
"F" Male to "F" Male	103-0157-00	$7.50
"F" Male to BNC Female	103-0158-00	$8.50
"F" Female to "F" Female	103-0159-00	$7.50



GR Insertion Unit	017-0030-00	$80.00
GR T	017-0069-00	$110.00
GR Elbow	017-0070-00	$110.00

SMA Male to GR	015-1007-00	$100.00
SMA Female to GR	015-1008-00	$100.00
SMA Male to N Female	015-1009-00	$50.00
SMA Male to 7 mm APC	015-1010-00	$175.00



SMA Male to Male	015-1011-00	$20.00
SMA Female to Female	015-1012-00	$16.00
SMA T	015-1016-00	$30.00
SMA Male to BNC Female	015-1018-00	$8.00

ACCESSORY HOUSING

Accessory housing without electrical components is useful for applications requiring special circuitry.

Accessory Housing	011-0081-00	$30.00

ATTENUATORS—TERMINATIONS

50 Ω ±0.1% precision feed-through termination (dc −100 kHz, 11 V RMS maximum)	011-0129-00	$95.00
50 Ω feed through termination*1	011-0049-01	$25.00
50 Ω 10X (20 dB) attenuator*2	011-0059-02	$35.00
50 Ω 5X (14 dB) attenuator*2	011-0060-02	$35.00
50 Ω (6 dB) attenuator*2	011-0069-02	$35.00
50 Ω 2.5X (8 dB) attenuator*2	011-0076-02	$35.00
50 Ω feedthrough termination (5 W)*3	011-0099-00	$40.00

vswr

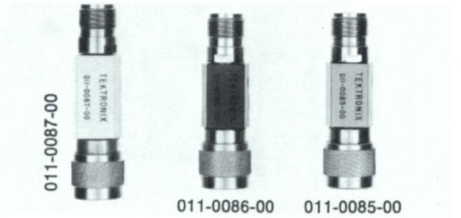
**1 <1.1 dc −250 MHz and <1.2 dc −500 MHz.*
**2 <1.1 dc −1.0 GHz and <1.2 dc −2.0 GHz.*
**3 1.1 dc −100 MHz.*

Characteristics — Dc resistance is 50 Ω ±1 Ω. Attenuation accuracy is ±2% dc, ±5% at 2 GHz. Power rating (except 011-0099-00) is 2 W average.

75 Ω feedthrough termination	011-0055-00	$25.00
93 Ω feedthrough termination	011-0056-00	$25.00
50 Ω to 75 Ω minimum loss attenuator	011-0057-00	$30.00
50 Ω to 93 Ω minimum loss attenuator	011-0058-00	$30.00
75 Ω 10X attenuator	011-0061-00	$32.00
93 Ω 10X attenuator	011-0062-00	$30.00
600 Ω feedthrough termination (1 W, dc to 1 MHz)	011-0092-00	$30.00
75 Ω to 50 Ω minimum loss attenuator (ac coupled)	011-0112-00	$60.00

Characteristics — Accuracy of indicated attenuation ratio is ±2% at dc.
Power rating of attenuators is ½ W and terminations 1 W.
Voltage standing wave ratio (vswr) not specified.

ATTENUATORS and TERMINATORS



Frequency range is dc to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω ±1.0 dB.

10 dB attenuator	011-0085-00	$70.00
20 dB attenuator	011-0086-00	$70.00
40 dB attenuator	011-0087-00	$90.00

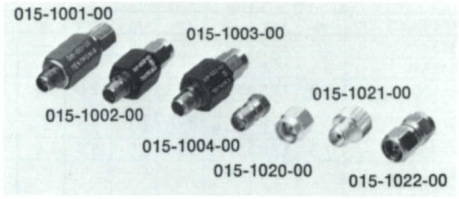
GR

50 Ω 10X attenuator	017-0078-00	$220.00
50 Ω 5X attenuator	017-0079-00	$210.00
50 Ω 2X attenuator	017-0080-00	$175.00
50 Ω termination, end-line	017-0081-00	$135.00

Characteristics — Accuracy of indicated attenuation ratio is ±2% at dc, ±3% at 1 GHz. Voltage standing wave ratio (vswr) is <1.1 up to 1 GHz. Power rating is 1 W.

Minimum acceptable order is $25.00.

3 mm 50 Ω



50 Ω 2X attenuator	015-1001-00	$120.00
50 Ω 5X attenuator	015-1002-00	$120.00
50 Ω 10X attenuator	015-1003-00	$120.00
50 Ω termination Female	015-1004-00	$60.00
Short-Circuit termination Male	015-1020-00	$17.50
Short-Circuit termination Female	015-1021-00	$24.00
50 Ω termination Male	015-1022-00	$32.00

Characteristics

	Dc—12.40 GHz		12.41—18.00 GHz		Power
	Attenuation		Attenuation		Continuous
	Accuracy	Vswr	Accuracy	Vswr	
Termination	±1 Ω	1.15	±1 Ω	1.15	0.5 W
2X (6 dB)	±0.75 dB	1.40	±1.00 dB	2.00	1.0 W
5X (14 dB)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W
10X (20 dB)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W

50 Ω COUPLING CAPACITOR

The coupling capacitor is a short length of coaxial line with a disk capacitor (4700 pF, ±20%) in series with the inner conductor. Reflection ratio (in 150 ps tdr system), is 0.03 maximum. Voltage rating is 200 V.

Coupling Capacitor SMA (3 mm)	015-1013-00	$180.00

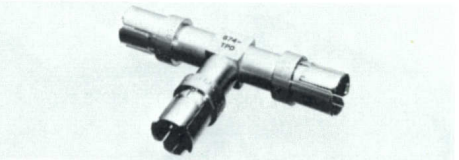
The coupling capacitor is a short length of coaxial line having a disk capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflection, but dc and low frequencies are blocked. Voltage rating is 500 V.

Coupling Capacitor GR	017-0028-00	$90.00

50 Ω POWER DIVIDERS

This coaxial tee is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. Load isolation is nominally 6 dB while the voltage attenuation ratio is nominally 2X (input to either load arm, other load arm terminated in a standard 50 Ω termination). Maximum vswr is 1.50 from dc to 12.00 GHz and 1.90 from 12.01 to 18.00 GHz.

Power Divider SMA (3 mm)	015-1014-00	$200.00



This coaxial tee has a 16.67 Ω resistor in each leg, connected so that the tee looks like 50 Ω if two legs are terminated in 50 Ω. It is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer set-up where test line, pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

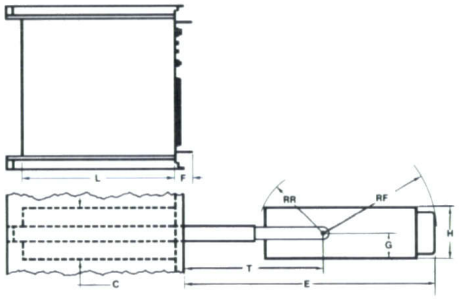
Power Divider GR	017-0082-00	$350.00

To order, call your local Tektronix Field Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

MOUNTING DIMENSIONS

	H		L		F		G		E		RF		RR		T		C	
PRODUCT	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
R434	5.3	13.5	18.0	45.7	1.6	4.0	—	—	—	—	—	—	—	—	—	—	5.3	13.5
R485*[1]	7.0	17.8	16.2	41.1	1.8	4.6	3.5	8.9	19.3	49.0	10.9	27.7	7.9	20.1	9.3	23.6	6.8	17.3
R5100 R5400*[1]	5.3	13.5	19.0	48.3	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.3	13.5
R5223	7.0	17.8	20.8	52.9	1.3	3.3	—	—	—	—	—	—	—	—	—	—	7.0	17.8
R7704*[1]	7.0	17.8	22.4	56.9	2.3	5.8	1.8	4.6	33.3	84.6	15.3	38.9	10.7	27.2	18.5	47.0	7.0	17.8
R7313*[1] R7603*[1] R7613*[1] R7623*[1]	5.3	13.5	22.3	56.6	2.0	5.1	—	—	25.2	64.0	—	—	—	—	—	—	5.3	13.5
R7844*[1]	7.0	17.8	24.8	63.0	2.3	5.8	1.75	4.4	—	—	—	—	—	—	—	—	7.0	17.8
R7903*[1]	5.3	13.5	22.8	57.9	2.3	5.8	—	—	25.3	64.3	—	—	—	—	—	—	5.3	17.8
R7912*[1]	5.3	13.5	26.9	68.3	1.8	4.6	—	—	26.9	68.3	—	—	—	—	—	—	5.3	13.5
7912AD	7.0	17.8	26.0	66.0	1.95	5.0	—	—	30.7	78.0	—	—	—	—	—	—	6.9	17.5
RTM506	5.25	13.3	18.9	48.0	1.82	4.7	—	—	—	—	—	—	—	—	—	—	5.25	13.3
T922R	5.2	13.2	17.0	43.2	1.7	4.3	—	—	24.2	61.5	—	—	—	—	—	—	5.2	13.2
016-0015-00	5.1	13.0	16.3	41.4	1.8	4.5	—	—	—	—	—	—	—	—	—	—	—	—
016-0115-02	5.3	13.5	16.3	41.4	0.3	0.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
016-0466-00	5.1	13.0	16.3	41.4	1.8	4.5	—	—	—	—	—	—	—	—	—	—	—	—
016-0468-00	5.2	13.3	14.9	37.8	2.0	5.1	—	—	—	—	—	—	—	—	—	—	—	—
016-0675-00*[1]	8.8	22.4	19.7	50.1	1.5	3.9	3.5	8.9	24.3	61.6	—	—	11.9	30.1	13.3	33.8	8.5	21.6
016-0676-00*[1]	7.0	17.8	19.7	50.1	1.9	4.8	3.5	8.9	24.3	61.6	11.1	28.2	11.2	28.4	13.3	33.8	6.9	17.5
016-0691-00*[1]	7.0	17.8	18.3	46.5	1.5	3.9	3.5	8.9	20.4	51.9	11.8	30.0	—	—	9.5	24.1	6.6	16.7
040-0551-01	14.0	35.6	22.4	56.9	0.6	1.5	—	—	30.9	78.5	—	—	—	—	—	—	—	—
040-0600-00	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.25	13.3
040-0601-00	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
040-0616-02	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.25	13.3
040-0617-02	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.3	13.5
040-0624-01	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
437-0031-00	8.8	22.4	9.5	24.1	0.3	0.8	—	—	—	—	—	—	—	—	—	—	5.25	13.3
437-0071-00	7.0	17.8	13.4	34.0	1.4	3.6	—	—	—	—	—	—	—	—	—	—	7.1	18.0
437-0126-03	5.3	13.5	22.3	56.6	2.0	5.1	—	—	25.2	64.0	—	—	—	—	—	—	6.6	16.8

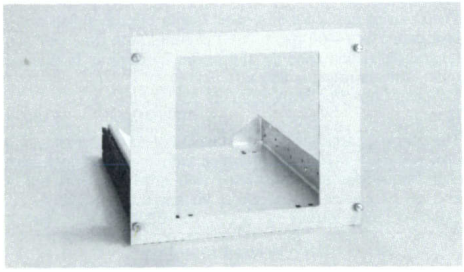
[1]These instruments mount with sliding tracks to a standard 19-inch wide rack. Rear support for sliding tracks is required, such as an enclosed rack.



DIMENSIONS EXCLUSIVE OF PLUG-IN UNITS AND PROBES

Symbol	Definition
H	Height of front panel
L	Rack front to rearmost permanent fixture excluding cables
F	Back of front panel to foremost protrusion
G	Bottom of front panel to horizontal plane of rotation
E	Maximum forward clearance with instrument out and horizontal
RF	Front radius of rotation
RR	Rear radius of rotation
T	Rack front to pivot point
C	Cabinet height

RACK ADAPTORS



For rackmounting the 7000 Series oscilloscopes in a standard 19 in wide rack. Rack adaptor includes slide-out assemblies. 7000 Series mask finish is light gray.

For 7704A, 7104, 7834 and 7854, rack height is 15.75 in, rack depth is 21.38 in, shipping weight is ≈41 lb.
Order 040-0611-01 ..... **$700**

For 455 and 465M, includes cradle mount, rack height 7 in, rack depth 18.75 in. Order 040-0825-01 ..... **$350**

For 2445 and 2465. Order 016-0691-00 ..... **$255**

For 2213, 2215 and 2235. Order 016-0466-00 ..... **$100**

For 2236. Order 016-0015-00 ..... **$200**

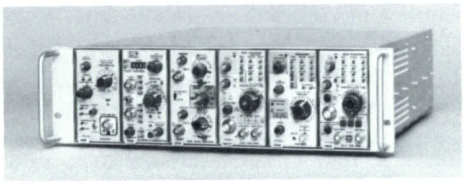
For 464 and 466. Order 016-0676-00 ..... **$325**

For 485. Order 016-0558-00 ..... **$320**

For 434. Order 016-0272-00 ..... **$200**

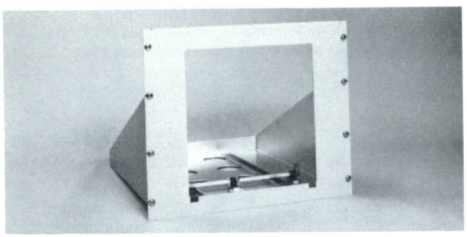
For 468. Order 016-0675-00 ..... **$325**

STORAGE CABINETS



For 7000 Series Plug-in Units — Holds 6 plug-in units, for mounting in a 19 in rack, 5.25 in high.
Order 437-0126-03 ..... **$750**

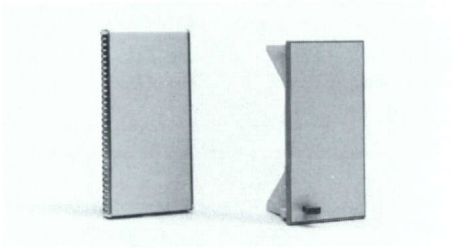
CRADLE MOUNTS



For rackmounting 7000 Series cabinet-type oscilloscopes in a standard 19 in wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 7000 Series mask finish is light gray.

For 7704A, rack height is 15.75 in, rack depth is 22 in, shipping weight is ≈16 lb. Order 040-0560-00 ..... **$445**

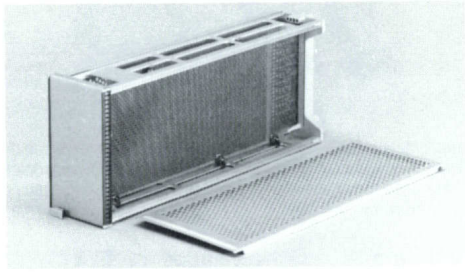
BLANK PANEL



Blank Panel — When operating the 5000/7000 Series mainframes or the TM 500 or 2600 Series generators with less than a full complement of plug-ins, the blank panel may be used to cover an unused compartment. The panel for the 7000 Series is also good for EMC Shielding.

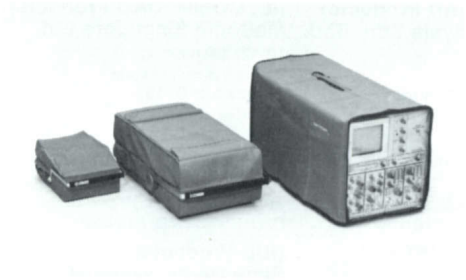
7000 Series, 2600 Series. Order 016-0155-00 ..... **$45**
5000 Series. Order 016-0452-00 ..... **$18**
TM 500 Series. Order 016-0195-03 ..... **$25**

BLANK PLUG-IN CHASSIS



Blank Plug-in Chassis — Available for all Tektronix mainframes. The 7000 Series provides a printed circuit board, plug-in frame, and securing hardware. The 560 Series, 1-Series, and Letter Series plug-in chassis have an interconnecting plug, securing hardware and plug-in frame.

7000 Series. Order 040-0553-01 ..... **$160**
5000 Series. Order 040-0818-03 ..... **$105**
TM 500 Series. Order 040-0652-05 ..... **$95**
560 Series. Order 040-0245-00 ..... **$150**



OSCILLOSCOPE PROTECTIVE COVERS

The cover provides protection for the oscilloscope during transport or storage. Made of waterproof blue vinyl, the covers are available for both laboratory and portable instruments. The covers for 500, 5000, and 7000 Series laboratory oscilloscopes have clear vinyl frontal areas.

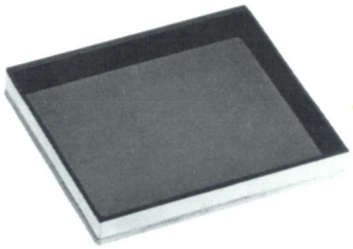
PROTECTIVE COVERS

INSTRUMENT	PART NUMBER	PRICE
200 Series	016-0512-00	$15.00
323,324,1401A,1401A-1, 1501	016-0112-00	$8.25
314,335	016-0612-00	$55.00
326	016-0532-00	$45.00
453A,454A,491	016-0074-01	$18.00
434,464,466	016-0365-00	$21.00
465,465B,475,485	016-0554-00	$17.00
5000 Series	016-0544-00	$25.00
7300,7400,7600 Series	016-0192-01	$20.00
7704A,7900	016-0531-00	$20.00

PLUG-IN UNIT CARRYING CASES

3-Wide Carrying Case for 7L14, 7L5 Option 25, 7D20, 7L18. Order 016-0626-00 ..... **$330**

2-Wide Carrying Case for 7L12, 7L5. Order 016-0625-00 ..... **$290**



CRT MESH FILTERS

The mesh filter improves display contrast for oscilloscope viewing under high ambient light conditions.

A fine metal screen with a matte black surface is utilized to reduce light reflections. Although light transmission from the CRT is reduced to approximately 28%, the high attenuation of external reflections allows viewing low-intensity displays in room light or other bright surroundings.

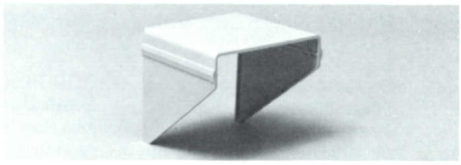
The mesh filter also serves as an EMC filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the EMC spectrum.

INSTRUMENT*1	PART NUMBER	PRICE
314, 326, 335	378-0063-00	$21.00
432, 434	378-0682-00	$60.00
422, 491, 453A, 454A, 485	378-0648-00	$24.00
465, 465B, 475, 464, 466, 434	378-0726-01	$55.00
7400, 7603	378-0696-00	$55.00
7500,7700,7800,7900 Series and 7613,7623 7633	378-0603-00	$55.00

*1 *For both cabinet and rackmount instruments.*

VIEWING ACCESSORIES

The viewing accessories listed normally mount on the oscilloscope graticule cover. In many cases, they will also fit camera-mounting bezels. If you intend using a camera on your oscilloscope, check with your Tektronix Sales Engineer for bezel-viewer compatibility before ordering.



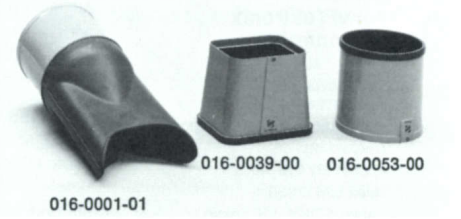
View Hood (Folding) — 314, 326, 335, 400 Series, 576, 577, 5000, and 7000 Series oscilloscopes.

For 576. Order 016-0259-00 ..... **$20**

For 577, 5000, and 7000 Series. Order 016-0260-00 ..... **$18**

For 326, 314, 335, SC 502, SC 504 (not pictured). Order 016-0297-00 ..... **$1.40**

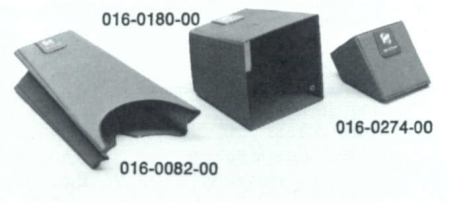
For 464, 466, 455 (not pictured). Order 016-0592-00 ..... **$12**



Polarized Viewers — For Tektronix older 5 inch oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.

Rectangular Viewer. Order 016-0039-00 ..... **$80**
Plastic Round Viewer. Order 016-0053-00 ..... **$42**

Viewing Hood — For Tektronix older 5 inch round oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield. Order 016-0001-01 ..... **$145**



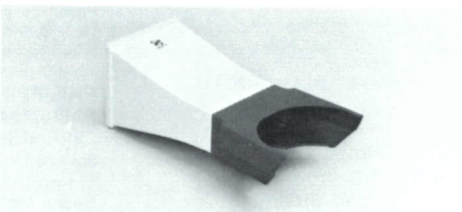
Collapsible Viewing Hood — For oscilloscopes with rectangular CRTs. Blue vinyl material, folds flat for convenient storage.

For 422, 453A, 454A, 485, 491. Order 016-0082-00 ..... **$15**

For 422, 453A, 454A, 485, 491. Order 016-0274-00 ..... **$15**

Viewing Hood (Folding Binocular) — For some 400 Series. **For 434, 455, 464, 466, 465B, 475 and 475A.** Order 016-0566-00 ..... **$15**

Polarized Collapsible Viewing Hood — To reduce reflections and glare under high ambient light conditions. **For 432, 434, 455, 465, 465B, 475, 464, 466.** Order 016-0180-00 ..... **$40**



Viewing Hood — Molded gray polystyrene with polyurethane eyepiece.

For 576. Order 016-0153-00 ..... **$40**

For 5000 and 7000 Series, 601, 602, 603, 604, 528 and 577. Order 016-0154-00 ..... **$28**

CATHODE-RAY TUBE LIGHT FILTERS

INSTRUMENT*1	COLOR	PART NUMBER	PRICE
200 Series	Blue	378-0691-00	$1.25
314,335	Blue	378-2016-01	$1.80
434	Blue	378-0678-01	$1.80
455,465M	Blue	337-2122-00	$5.25
465,465B,475, 464,466	Blue	337-1674-00	$5.00
	Clear	337-1674-01	$5.00
	Smoke-gray filter	337-1674-07	$4.00
540,550 Series 565,575	Smoke-gray†	378-0567-00	$9.00
	Green	378-0568-00	$4.00
	Blue	378-0569-00	$4.00
	Amber	378-0570-00	$4.00
576	Blue†	378-0616-00	$5.00
603,604	Clear (603†)	337-1440-00	$3.00
	Green	337-1440-01	$3.00
	Amber	337-1440-02	$3.50
	Blue	337-1440-03	$3.50
	Gray	337-1440-04	$4.50
	Graticule (8x10 div)	331-0303-00	$10.00
605,606,607	Blue	337-1674-00	$5.00
	Graticule	337-1674-10	$5.00
	Clear Shield	337-1674-13	$5.00
	Gray†	337-1674-06	$5.00
	Graticule (8x10 div)	331-0391-00	$5.00
608	Amber	378-0704-00	$5.00
	Graticule†	337-2126-02	$5.25
2200 Series	Blue†	337-2775-00	$3.00
2300 Series	Blue Implosion Shield†	337-2760-00	$1.65
	Clear Implosion Shield†	337-2781-00	$4.40
2400 Series	Blue†	378-0199-00	$0.60
	Clear Implosion Shield†	378-0208-00	$0.70
5100 and 5400 Series (except 5441)	Clear	337-1440-00	$3.00
	Green	337-1440-01	$3.00
	Amber	337-1440-02	$3.50
	Blue	337-1440-03	$3.50
	Gray	337-1440-04	$4.50
5441	Clear†	337-1674-01	$5.00
	Gray	337-1674-06	$5.00
	Graticule (8x10 div)	331-0391-00	$5.00
7403N,7603	Blue	378-0684-00	$7.00
	Amber	378-0684-01	$7.00
	Gray	378-0684-02	$7.00
	Green	378-0684-03	$7.00
	With Spectrum Analyzer Graticule	337-1439-01	$8.00
	Blue Implosion Shield†	337-1700-01	$6.50
	Clear Implosion Shield	337-1700-04	$6.50
7613,7623 7623A,7633	Spectrum Analyzer	378-0625-07	$9.50
	Green (UV)	378-0625-08	$5.00
7904,7844 7313,7700 Series,7613 7623	Blue†	378-0625-00	$5.00
	Amber	378-0625-01	$5.00
	Gray	378-0625-02	$5.00
	Green	378-0625-03	$5.00
	Gray Tv Graticule NTSC	378-0625-06	$9.50
	Clear Shield With Spectrum Analyzer Graticule	337-1159-02	$8.00

*1 *For both cabinet and rackmount instruments unless rackmount version is listed.*

† *Standard filter supplied with instrument.*

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Sales Office Listing on 462-Inside Back Cover
Functional Index on pages 2-5
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